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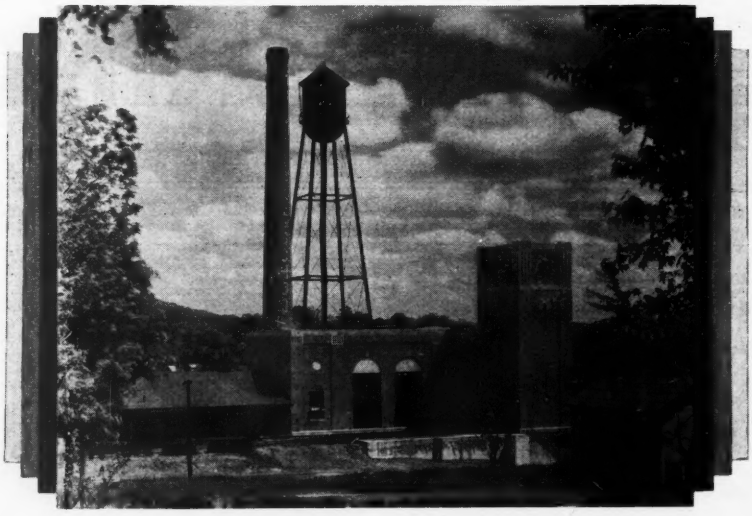
Page the Cake Eaters! Hey! Hey!

PRIME MOVERS in the old days, when the West was young, were of the ancient "hay burner" type. Old timers admit that the B.t.u. rate was high but efficiency engineers were scarce and the hardy men who used the hay burners were too busy building sod houses and convincing themselves that Nebraska was really a habitable state to worry about such a relatively unimportant matter.

This hardy life developed a race of persistent people who civilized and, with their descendants, continued to occupy the Middle West. That is, they continue to occupy it until they discover Florida or California after which, it has been intimated by certain interested parties, they are not so sure about the civilized part and move west or south, pending further investigations.

In spite of these nasty insinuations, it is a safe bet that if the chubby, barefoot, tow-headed youngster in the picture inherited any of his father's pioneering spirit, he has forgotten about oxen, uses horses only to pull his flivver out of the mud and utilizes electricity to its fullest extent from milking the cows on down the line to doubling the egg rate of the hens, putting the chicks to bed by alarm clock and a thousand other uses as will be brought out by Charles S. Stuart in his article, "Farm Relief," to appear in the February 15 issue.

In fact, electrical loads in both city and rural districts are growing so rapidly that it is difficult to keep the installed capacity ahead of the demand. Fremont, Neb., one of the romantic cities of the old west and an important one in the new west, with true pioneering spirit, recently abandoned the old and built a new municipal power plant at a cost of about $100 a kilowatt of capacity. A description of the plant with complete cost and test data begins on page 175.



New Plant Built on Site of Old Without Interrupting Service

BUILDING A NEW power plant of any kind is always a task of considerable importance and one requiring careful thought on the part of the designing engineers but when such a new plant has to be constructed on the site of an old plant without interrupting service, the undertaking becomes doubly difficult. Yet it was under just such circumstances as these that the new plant at the Indiana State Normal School at Indiana, Pa., was constructed. The result, as is clearly shown by the accompanying photographs, is a credit to the designers and constructors, and certainly does not indicate that any unusual conditions prevailed during the period of construction. The old plant was maintained in operation until the new boilers were erected and the load changed from the old to the new in a few hours' time; there was, in fact, no interruption of service.

Indiana, Pa., where this plant is located, is about 50 mi. northeast of Pittsburgh. The Indiana Normal School, which it serves, is one of a number of such institutions in the State of Pennsylvania, all of which, so far as the mechanical features are concerned, are under the direction of M. D. Heastings, who was the designer of the Indiana plant described in this article.

For a number of years, ever since the school was established, in fact, the buildings at the Indiana Normal School had been served with power, heat and light by a plant consisting of five 125-hp. horizontal return tubular boilers and a 15 by 18-in. Ball piston valve engine driving a 2300-v. generator. Because of the steady growth of the school, the old plant had become inadequate to meet the needs of the heating load, so it became necessary about two years ago either to increase the capacity of the old plant or to build an entirely new plant. The old boilers had just about reached the end of their useful life, so it was decided to build a new boiler plant of modern design. As the generating units were sufficiently large and in good condition, it was not thought necessary to replace them.

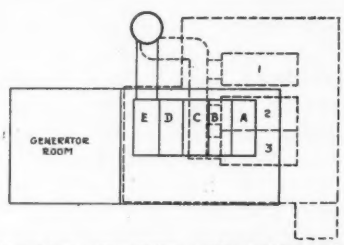


FIG. 1. DIAGRAM SHOWING RELATIVE POSITIONS OF OLD AND NEW PLANTS. OLD BUILDING AND BOILERS INDICATED BY SOLID LINES. NEW BOILER HOUSE AND BOILERS SHOWN BY DOTTED LINES

Accordingly, plans were drawn up for a new boiler plant to be used in conjunction with the existing generating unit. The plant was built in remarkably short time, contracts being awarded on July 19, 1927, and steam being turned on the new boiler on September 9, less than two months later. Of course, the new building was not completed in that short time but one of the boilers was actually put on the line on that date, the boiler being operated in the open, under tarpaulins. This remarkably quick work was the result of perfect coöperation between Mr. Heasting's department and Herre Brothers, of Harrisburg, the contractors.

Of the old boiler plant, the only part that was retained was the stack. The old stack was in excellent condition and as it was located so that it could be utilized with the new plant, it became the nucleus around which the new boiler plant was built.

In carrying out the work, the building housing the old boilers was first dismantled. The old h.r.t. units were set in a row at right angles to the present boilers, the approximate arrangement being that shown in Fig. 1.

Since the work was started in the summer, the heating load was a minimum and could easily be carried by three of the old boilers. Two of the old boilers,

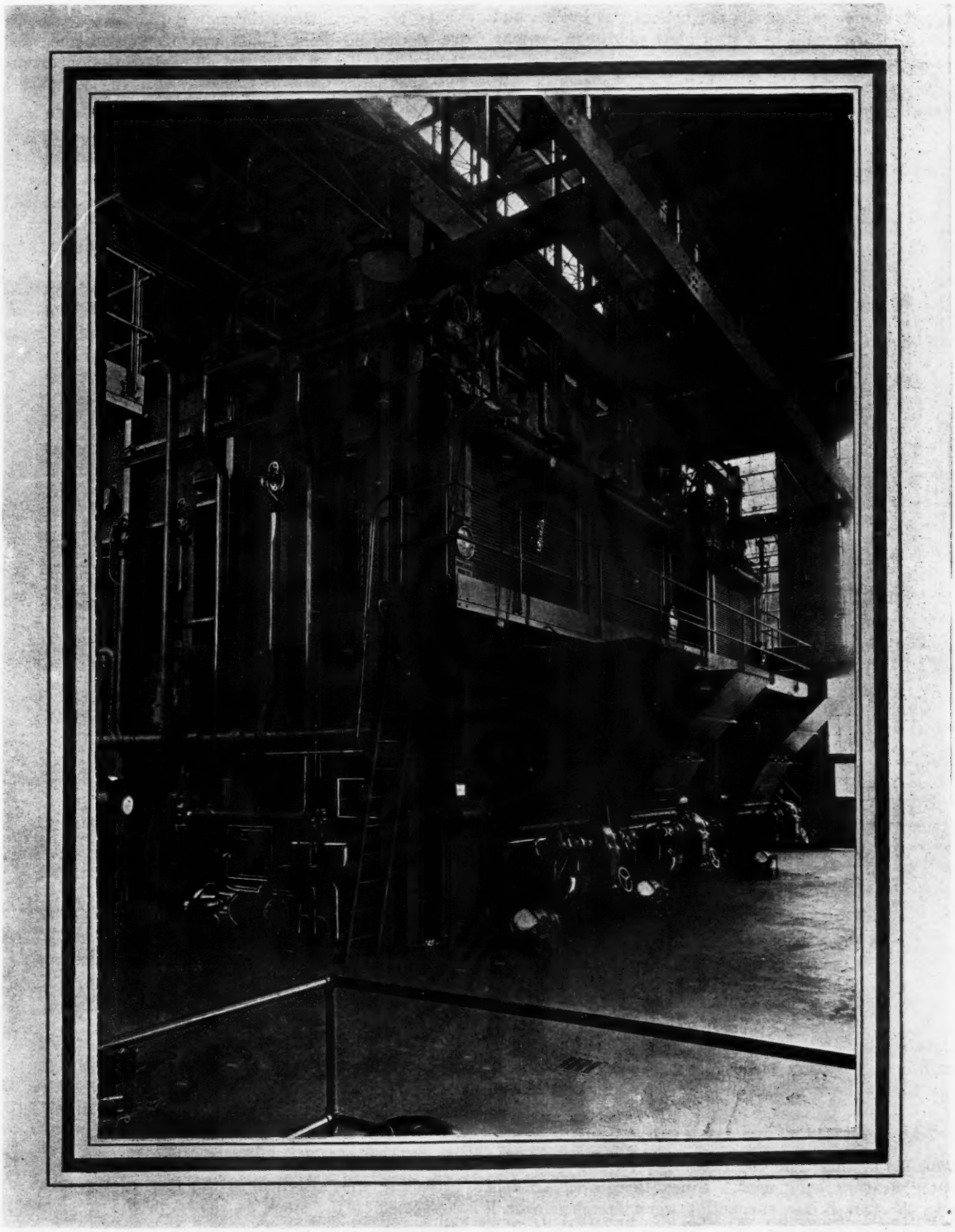


FIG. 2. THESE THREE MODERN WATER TUBE BOILERS REPLACE THE FIVE OLD HORIZONTAL RETURN TUBULAR UNITS

As may be noted from this photograph, the new boiler room is provided with an abundance of room. All parts of the boiler and piping are easily accessible. The boiler feed pumps are located directly behind the first two units.

numbers A and B in Fig. 1, were dismantled, so as to make room for the new units. The breeching which ran across the front of the old boilers was broken and blocked off by means of a steel plate welded in, as may be seen in Fig. 2.

As soon as the first new boiler was erected, a connection was made to the stack and the unit started, to carry the entire load on the first new boiler while the second and third units were being installed.

At the same time, the new building was erected. The entire old boiler house was dismantled and in its place a brand new structure of modern design erected. The new boiler house is L-shaped with the old stack in the inside angle of the L.

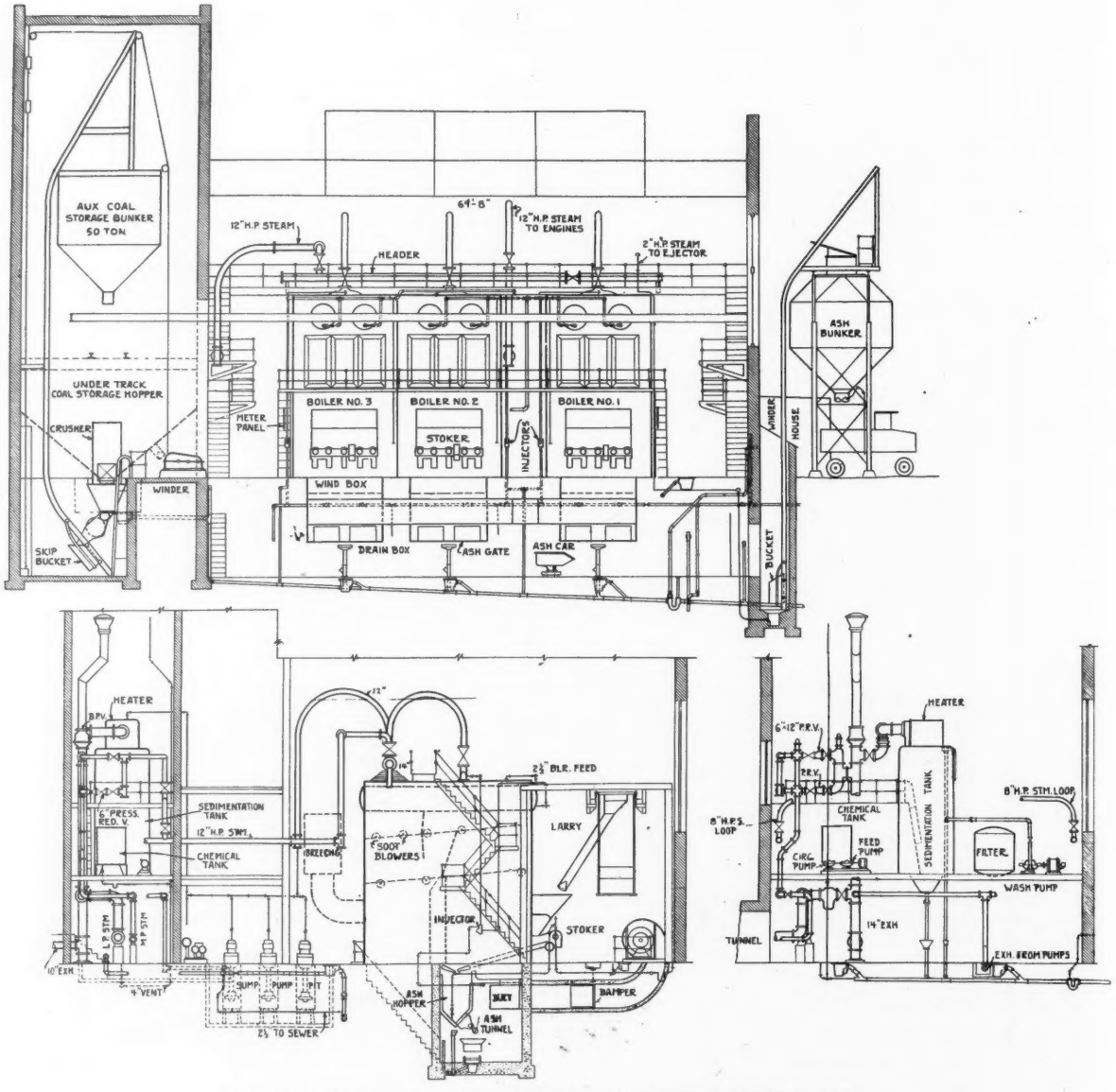


FIG. 3. SECTIONS AND ELEVATIONS OF THE NEW BOILER PLANT

utilizing at this time the existing pumping and feedwater heating equipment. Since there was no roof over the new boiler, tarpaulins were stretched over it to protect it from the rain. The roof was not put in place until December, although steam was raised in the boiler on September 9.

The next step in the work was the dismantling of the remaining old boilers and the erection of the two other new units. The old boilers were rated at 125 hp., the new ones, 391; it was a simple matter, therefore,

When the three new boilers were in place, a new breeching was installed in the rear of the units, and connected to the stack as shown in the accompanying drawings.

The result of this extremely interesting work was not, as might be expected and as is so often the case, a remodeled boiler room with some new equipment, but a thoroughly new plant with no old equipment carried over from the old plant. All the old equipment was junked and all new equipment purchased for the new

plant. The result, naturally, is a modern, efficient boiler plant, neat in appearance and attractive from an architectural viewpoint.

Details of New Plant

An excellent idea of the general arrangement of the new plant may be had from the plan drawing in Fig. 4. The three new boilers are Edge Moor, water-tube units, having 3910 sq. ft. of heating surface, with the baffling arranged so as to form four passes. There are 14 vertical and 13 horizontal rows of 4-in. tubes, 20 ft. long. A cross section of one of the units, shown in Fig. 7 gives further details.

These boilers are fired by Westinghouse Electric & Mfg. Co., four retort, underfeed stokers, motor driven and equipped with a steam dumping arrangement. These stokers are controlled automatically by a Hagan control system.

Forced draft for all units is supplied by 2 Buffalo Forge Co. double width fans, capable of furnishing 26,000 cu. ft. per min. against 4½ in. static pressure.

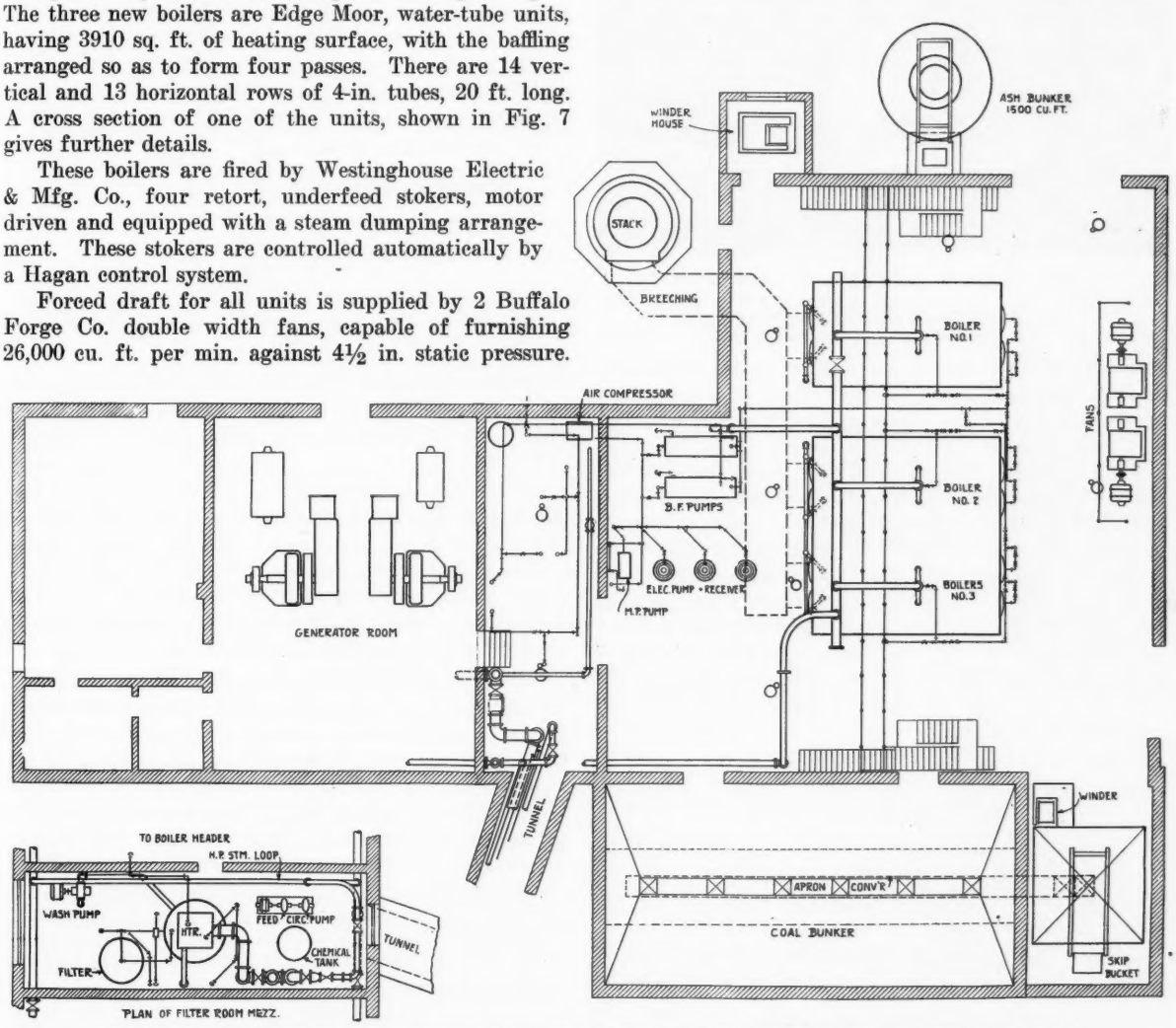


FIG. 4. PLAN OF THE PLANT SHOWING THE NEW BOILER ROOM AND THE OLD GENERATOR ROOM

These fans are installed directly in front of the boilers on the operating floor. From the fans, the air passes through a 42 by 39-in. concrete duct having 8-in. walls, to a 48 by 39-in. steel duct underneath the stokers. The forced draft fans are each driven by 40-hp. Westinghouse motors, automatically controlled from the Hagan system.

All auxiliary apparatus with the exception of the forced draft fans, is located at the rear of the boilers. All pumps are installed on the operating floor level while the feedwater heater, water softener and associated equipment is located on a mezzanine floor.

Water for all purposes is taken from the city mains. All water, including returns from the system is delivered into a sump tank, from which it is pumped into a Cochrane hot process softener and heater. From the softener, it is pumped into the boilers by either of two Warren, duplex 12 by 6 by 12-in. steam pumps controlled by Fisher governors. Feedwater is heated to 212 deg.

Besides the boiler feed pumps, there are three 2-in. vertical Warren sump pumps, electrically driven, and one high pressure, Warren pump and receiver for high pressure drip service. The three sump pumps are installed in one tank, with floats arranged at different levels, so as to start the pumps successively as the water in the tank rises.

In the boilers, the water level is controlled by Copes feedwater regulators.

Coal and Ash Handling

All coal and ash handling equipment was supplied by the R. H. Beaumont Co. The coal handling apparatus consists of an undertrack storage hopper, crusher, an auxiliary storage hopper and a weigh larry. Coal is received by railroad, the cars being run up an incline over the under track storage hopper into which the cars are emptied. A horizontal apron conveyor running under the storage hopper removes the coal from storage

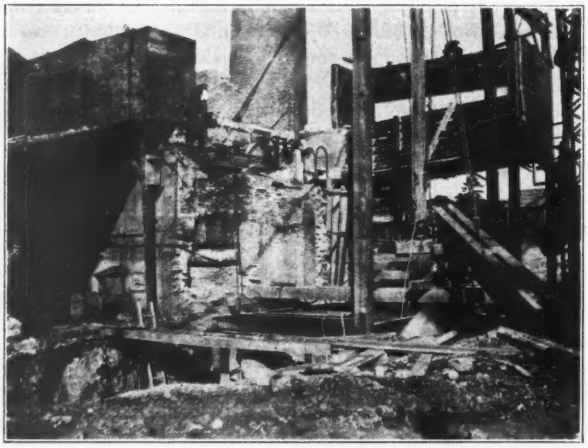


FIG. 5. PHOTOGRAPH TAKEN SHORTLY AFTER ERECTION OF FIRST NEW BOILER WAS STARTED. NOTE OLD BOILERS BEING OPERATED AT THE LEFT

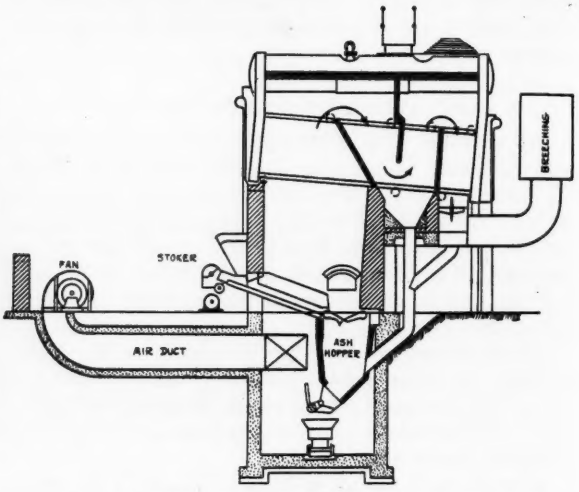


FIG. 7. SECTION OF ONE OF THE NEW BOILERS

and delivers it to a double roll crusher having a capacity of 30 t. per hr. After being crushed, the coal drops into a skip bucket and a skip hoist elevates it to a 50-t. overhead auxiliary coal storage hopper. This overhead bunker is installed in an attractive brick tower at the corner of the boiler house. This method of concealing the coal bunker, although perhaps somewhat more expensive is entirely justified from an esthetic viewpoint. Money spent in making industrial structures architecturally attractive is money well spent and as has often been shown, does not materially increase the fixed charges. In this case, the additional protection afforded the overhead bunker will probably decrease the cost of upkeep and thus compensate for the additional expenditure of the tower.

Coal is drawn from the bottom of the auxiliary bunker and delivered to the various stoker hoppers by a one-ton automatic weigh larry.

The system of ash disposal is simple and effective. As can be seen from the drawings, ash is delivered into an 18-cu. ft. ash car, running on narrow gage rails underneath the ash hoppers. This car is run to the end of the boiler house where its contents are transferred to an ash skip bucket of 20-cu. ft. capacity and elevated to the steel ash bunker outside of the boiler house. This ash bunker is 14 ft. in diameter and has a total volume of 1500 cu. ft. From the ash bunker the ash is delivered to trucks.

This plant is particularly well equipped with instruments and regulating equipment for securing efficient operation. Boiler equipment includes Bailey boiler meters, Ranarex CO_2 meters, Bailey multi-pointer draft gages, Bailey flow meters, Diamond soot blowers, Yarway tandem blowoff valves, Consolidated safety valves, Penberthy injectors and Crane stop valves.

All piping is Jones and Laughlin extra heavy with all joints welded, using Van Stone joints. Valves and fittings with few exceptions are all Crane, extra heavy. Other equipment in the boiler house includes a Swartwout exhaust head, Boylston reducing valves, Crane relief valves, McAlear back-pressure valves, Boylston high-pressure drip traps and Webster low-pressure drip traps.

Feedwater returns and water softener temperatures are measured by Brown recording thermometers.

A concrete blowoff tank is provided with a baffle 12 ft. from the end.

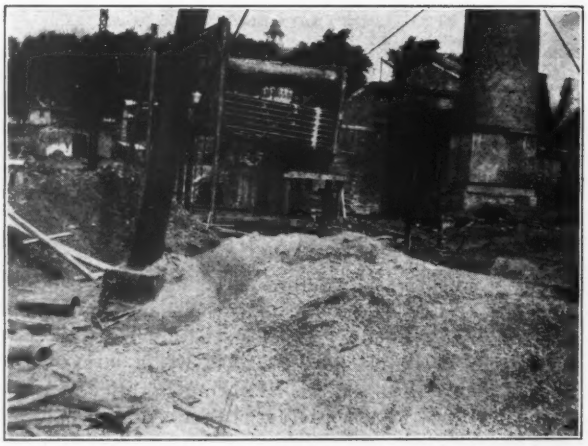


FIG. 6. ANOTHER VIEW TAKEN DURING CONSTRUCTION. OLD STACK AND BREECHING SEEN AT THE RIGHT

FIG. 8. A VIEW AT THE REAR OF THE BOILERS SHOWING METERS AND SOOT BLOWERS

Plant Serves Large Heating System

This new boiler plant supplies not only the heating load but also the old generating units. The latter are engine-driven units and were left unchanged.

In connection with the heating of the school, which comprises many buildings, an elaborate underground tunnel system was constructed for carrying the steam, water, telephone and electric power lines. The constructional features of this tunnel system, the method of running the pipes, methods of compensating for expansion, etc., are of exceptional interest and will warrant an article devoted to that phase of the plant alone. This will be published in a subsequent issue.

In concluding this article, we wish to acknowledge our indebtedness to M. D. Heastings of the Bureau of School Buildings, Commonwealth of Pennsylvania, who designed the plant, for valuable assistance in furnishing the material on which this article is based. Credit is due, also, Herre Bros. of Harrisburg, Pa., the contractors and to the Edge Moor Iron Co. for furnishing the photographs.

How to Check Your Economizer Guarantees

Test Conditions Can Be Corrected For, to Make Them Comparable with the Guarantees. By Brian M. Thornton

WHEN ECONOMIZERS are purchased, the buyer is supplied with performance curves, or data, from which he may estimate the probable performance of his plant as a whole under various conditions. The designer of an economizer has to rely on data supplied to him by the station designer or the manufacturers of the other station equipment, in order to proportion his heating surface for the specified duty. In practice, however, it rarely happens that the other equipment performs under test exactly as estimated, with the result that the economizer performance is not as forecast and the buyer is faced with the problem of determining from the actual test figures, whether the economizer would have met its guaranteed performance if the conditions for which it was designed had prevailed.

It is the purpose of this article to describe a method for checking the performance of an economizer, on similar equipment such as an air heater, when such a problem occurs. This procedure is fair to all parties concerned. It is rather surprising that more attention has not been devoted to these problems which arise in the boiler house and adjustments made just as turbine manufacturers adjust their test performance figures with correction curves for pressure, superheat, vacuum, and partial load, which are agreed upon previously with the buyer.

Information which the economizer designer must have before he is able to get his sizes is: 1, ratio of the weights of the gas and water passing through the economizer at various boiler ratings; 2, temperature of the flue gases entering the economizer at various boiler ratings; 3, temperature of the water entering the economizer at various station loads.

Departure from guarantees or estimated performances with any one, or all, of the three factors enumerated, will alter the estimated economizer performance and in some cases the departure has been quite serious. A few years ago, the author tested an economizer installed behind a new design of boiler in a British power station and found that the temperature of the flue gases leaving the boiler was over 100 deg. F. higher than estimated. This was, to a certain extent, anticipated, as practically no test data on this type of boiler existed at the time. Similarly, at a plant in California, while the inlet gas temperatures were close to the estimated, the temperature of the inlet water to the economizer was nearly 20 deg. higher than estimated, owing to excessive steam leakage to the turbine high pressure gland heater.

Most Frequent Cause of Discrepancies Lies in Departure from Estimated Ratio of Gas and Water

Most frequently, the cause of departure from the estimated performance is in the ratio of weights of gas and water. This may be due to defective fuel burning equipment, with a consequent lower CO_2 than anticipated or, more frequently, to the use of a fuel with burning characteristics differing considerably from the "standard" station fuel used as a basis for design. It is intended here to discuss only the more important guarantee figures, such as the gas temperature drop and the water rise, but it is obvious that further guarantee figures, such as the draft loss, may also be affected.

Methods of correction may be described briefly before developing or using any formulas. In order to calculate what the economizer performance should be under the new conditions, it is necessary to know the designers' assumptions. Without knowing exactly what law was used in the variation of the heat transfer coefficient, with the gas formula quantity it is possible to get the law for the particular economizer being considered quite simply from the guarantee figures. With this formula determined, it remains only to calculate what the performance guarantee figures would have been under the actual conditions and compare them with the test results.

In the solution of any economizer problem, it is necessary to know the ratio of the weights of gas and water which may be determined directly from

$$w\ (t_2 - t_1) = CW\ (T_1 - T_2) \qquad 1$$

where t_1 and t_2 are the initial and final water temperatures and T_1 and T_2 the initial and final flue gas temperatures; C, the mean specific heat of the gases, may in ordinary practice be assumed constant at 0.245; w and W are the weights of water and flue gas passing through the economizer per hour. The water temperature rise and the gas temperature drop, determined from test, are the only measurements necessary to calculate $W \div w$ the ratio of the weights of flue gas and water. W is determined directly if w is metered, either as water or steam.

Economizer efficiency, E, is defined as

$$E = (T_1 - T_2) \div (T_1 - t_1) \qquad 2$$

and its value is determined from the temperature measurements made to evaluate W ÷ w. The value of CW ÷ w may conveniently be written as K. Then it is clear from Eq. 1 and Eq. 2 that:

$$(t_2 - t_1) = EK\,(T_1 - t_1) \qquad 3$$

It may also be shown that

$$F = RS \div CW \qquad 4$$

where F is the value of the function

$$\text{Log}_e \left\{ [(1 - EK) \div (1 - E)] \div (1 - K) \right\} \qquad 5$$

If R is the rate of heat transfer from gas to water

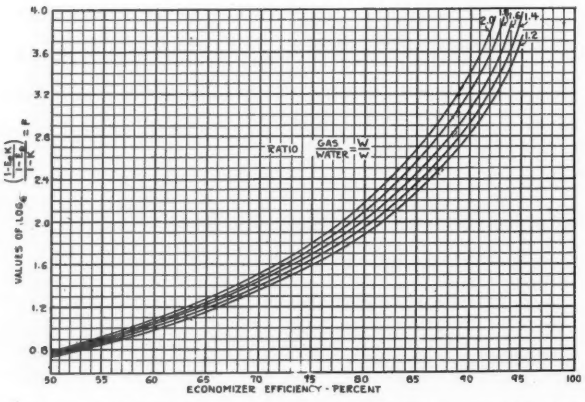


FIG. 1. CALCULATED CURVES SHOWING ECONOMIZER EFFICIENCY AS A FUNCTION OF F

in B.t.u. per square foot of heating surface per hour per degree Fahrenheit mean temperature difference between gas and water and S is the heating surface in square feet, the first problem is to determine how R varies with the velocity or weight of gas flowing past the tubes. In the modern high speed economizer R is often a linear function of the weight of gases passing through the economizer in a given time. In other words, the heat transfer follows Reynold's law, or

$$R = a + b\,W \div A \qquad 6$$

where a and b are constants determined from experiments and A is the area for gas flow. With an existing economizer A is constant and for that particular economizer Eq. 6 may be written

$$R = a + BW \qquad 7$$

where B is an experimental constant. Economizers, however, do not necessary follow Eq. 7 and in some cases

$$R = C_1\,(W \div A)^n \qquad 8$$

or, for a particular design

$$R = C_2\,(W)^n \qquad 9$$

where C_1 and C_2 are experimental constants and n is an exponent usually lying between 0.7 and 0.8. From an examination of the guarantee performance figures, it is a simple matter to see what form of law the designer has assumed; but, for the particular problems being considered, it is necessary only to get the relation of W and R by drawing a curve from the guarantee performance figures as shown in Fig. 2. This is the only information required from the guarantee data.

Test Data and Curve Data Both Used in Check

From actual test figures, the buyer can determine the actual W; from Fig. 2 the value of R and then, the gas temperature drop and water rise which would have been the guarantee figures under the actual test conditions, may be calculated. If these readjusted guarantee figures agree within a few degrees of the actual test figures, the buyer should be satisfied that the economizer is up to its work. The method will be made quite clear by taking a concrete example.

TABLE I. GUARANTEE FIGURES FOR A 3888 SQ. FT. ECONOMIZER

	A. Normal	B. Max.	C. Normal	D. Max.
CO_2, per cent	12	12	14	14
Evaporation, lb. per hr.	35,000	42,000	35,000	42,000
Lb. of gas, per hr.	65,100	79,200	54,890	66,750
Feed water deg. F.	150	150	150	150
Gas leaving econ. deg. F.	322	352	280	310
Water leaving econ. deg. F.	295	304	261	270

An economizer of 3888 sq. ft. heating surface is sold under the guarantee figures shown in the table. From

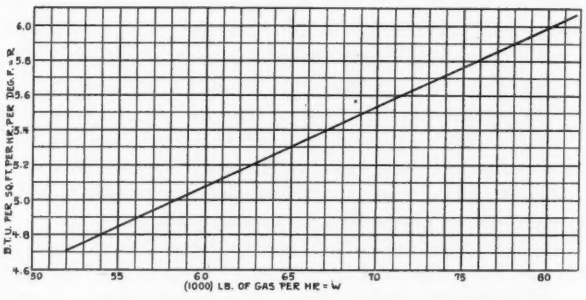


FIG. 2. HEAT TRANSFER CURVE OF A PARTICULAR ECONOMIZER DRAWN FROM GUARANTEE FIGURES

this table, the gas temperature entering the economizer, T_1 may be calculated from Eq. 1 as for example, with the figures in column A.

$$T_1 - T_2 = 35000 \times 145 \div 0.245 \times 651000 = 312$$

and $$T_1 = 312 + 322 = 634 \text{ deg. F.}$$

Knowing the initial and final gas and water temperatures, the logarithmic mean temperature difference (MTD) may be calculated from:

$$MTD = (T_1 - t_2) - (T_2 - t_1) \div \text{Log}_e\,[(T_1 - t_2) \div (T_2 - t_1)] \qquad 10$$

and then R from:

$$R = w\,(t_2 - t_1) \div (S \times MTD) \qquad 11$$

It is more convenient, however, to evaluate R by using the calculated curves in Fig. 1. Then from Eq. 2 with the figures in the column A,

$$E = (634 - 322) \div (634 - 150) = 312 \div 484 = 0.645$$

and since $$W \div w = 65{,}100 \div 35{,}000 = 1.86$$

F, from Fig. 1, equals 1.28 so that from Eq. 4 and the figures obtained above,

$$R = (1.28 \times 0.245 \times 65{,}100) \div 3888 = 5.26$$

Repeating this procedure for all four columns, B, C and D, Table II, may be compiled from this data, which shows the heat transfer law for this particular economizer, Fig. 2 is drawn.

TABLE II. CALCULATED DATA GIVING HEAT TRANSFER LAW OF 3888 SQ. FT. ECONOMIZER

	A	B	C	D
E	0.645	0.6225	0.69	0.6575
W ÷ w	1.86	1.88	1.568	1.59
F	1.28	1.19	1.40	1.28
R	5.26	5.94	4.84	5.38

Under actual test conditions, this economizer gave the following results:

Evaporation, lb. per hr.....	39,600
Gas entering Econ., deg. F.....	674
Gas leaving Econ., deg. F.....	336
Water leaving Econ., deg. F.....	319
Water entering Econ., deg. F.....	161

From these figures

$$W = 39{,}600\ (319 - 161) \div 0.245\ (674 - 336) = 75{,}600$$

From Fig. 1, with W = 75,600, R = 5.79 and

$$F = (5.79 \times 3888) \div (0.245 \times 75{,}600) = 1.215$$

Since from Fig. 2 $W \div w = 75{,}600 \div 39{,}600 = 1.91$

$$E = 0.63.$$

Water temperature rise which should have been obtained is then found from Eq. 3 as

$$t_2 - t_1 = 0.63 \times 0.468\ (674 - 161) = 151.5 \text{ deg. F.}$$

Actually the water rise was 158 deg. F. and the economizer is therefore exceeding its estimated performance by 6.5 deg. F.

Embrittlement Prevention in Steam Boilers*

DATA FROM EXPERIENCE IN THE USE OF SULPHATE, PHOSPHATE AND ORGANIC TREATMENT. BY FREDERICK G. STRAUB†

IT IS THE general consensus of opinion among engineers that the embrittlement of boiler plate is due to the concentration of caustic in the seams. It has been found in the laboratory that embrittlement occurs when certain definite concentrations of caustic have been reached and when the test piece is under a definite minimum strain. It has also been found that the addition of soluble sulphates, or certain other substances, under certain conditions will inhibit this effect.

Three laboratory methods to prevent embrittlement are available. They are as follows:

1. The maintenance of a sodium sulphate to sodium carbonate alkalinity ratio.
2. The maintenance of a definite phosphate concentration.
3. The maintenance of certain organic matter concentrations.

These methods have been tried in the laboratory and found to be effective. Since the application of any one of these methods to plant operation must not be made until certain plant data are available to check the laboratory results, the author has been collecting the desired plant data.

SULPHATE TREATMENT

Plant data on sulphate treatment to inhibit embrittlement date back to 1915 when the use of sulphuric acid to neutralize in part a natural sodium carbonate water was adopted at the University of Illinois power plant. The water was treated so as to maintain a ratio of sodium sulphate to total alkalinity expressed as sodium carbonate equal to 2 for 160 lb. steam pressure. These boilers, receiving this treated water, have operated 13 yr. without embrittlement difficulty. During this time, two power plants in the Champaign-Urbana district, operating at 160 lb. pressure on untreated water, have encountered embrittlement.

In another community a well water, free from sodium carbonate, received water treatment which introduced a high sodium carbonate alkalinity into the boiler water with a low sulphate content. A plant having the treated water has encountered a serious case of embrittlement, while one plant has operated on the untreated water for years free from trouble. Adoption of a recommendation by the American Society of Mechanical Engineers Boiler Code Committee in 1926, advising the maintenance of the following ratios, has undoubtedly done much toward helping power plants eliminate this trouble.

Working Boiler Pressure, Lb. Gage	Ratio of Alkalinity as Sodium Carbonate, to Sodium Sulphate
0 to 150	1 to 1
150 to 250	1 to 2
250 and over	1 to 3

It should be kept in mind that this is only a rule of thumb ratio which, in turn, must be established by the results of plant operation. These ratios run only to 250 lb. pressures and leave the ratio for such pressures as 500 lb., or higher, to be determined. The man operating a plant at 500 lb. pressure should hold the ratio to at least 1 to 5 in order to receive full protection.

Recently, the author investigated a plant which encountered embrittlement after three years operation at 375 lb. pressure. The boiler water had been analyzed regularly since the boilers went into operation and the sulphate alkalinity ratio determined. Due to scale formation, it was rather difficult to maintain the ratio of sulphate to carbonate at even 3 and, for the greater portion of the time, the sodium sulphate was between 1 and 1.5 times the alkalinity. Here, apparently, the

*Data in part from Bulletins 155, 157, Eng'g Exp. Station, Univ. of Ill. Authorized by Dean M. S. Ketchum of the Experiment Station.

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maintenance of the ratio was second to operation. In plants desiring to prevent embrittlement, the proper ratio must be set and the boiler water kept above the set figure at all times. The ratio is not a mark toward which to aim but a minimum value which must be maintained in order to receive protection.

As to whether or not temporary operation, without the maintenance of the proper ratio, is dangerous, the question can be answered by the statement that embrittlement has occurred in new boilers operating but 13 mo. These boilers were in a dangerous condition, which shows that embrittlement may act rapidly and would indicate that even short periods of operation without the proper ratio are inadvisable.

Results of the laboratory work on the inhibiting effect of sulphate show that, unless the proper ratio is maintained, there is no protection. Half the ratio is no better than none. This, again, should emphasize the statement that the ratio is a minimum value and should be conscientiously maintained at all times.

In all the instances of embrittlement which have been investigated, not a single one has occurred on boiler waters which met the A. S. M. E. recommendation. This appears to indicate that the ratios are correct for pressures up to 250 lb. at least.

Phosphate Treatment

Discovery, early in 1927, that phosphate could be used in the laboratory to inhibit embrittlement immediately suggested the possibility of the use of phosphate to replace the sulphate treatment. The amounts of soluble phosphate necessary were much smaller than for the sulphate. Phosphate could be used in small amounts; it would aid in keeping the steaming surfaces clean; it would not cause corrosion and an excess of it would not be dangerous. With the results of the laboratory work available, which had checked the plant data on sulphate so effectively, it might seem logical to recommend the phosphate treatment to replace the sulphate but this has not been done. The use of phosphate to prevent embrittlement must be backed by additional data from operating plants as well as from the laboratory, before it can be recommended to replace the sulphate ratio.

At present, a limited number of plants are in operation using soluble phosphate to prevent embrittlement. The sulphate ratio is being ignored in these plants. In order to make certain that the proper amounts of phosphate are present at all times, the boiler waters are analyzed at the plant daily and the phosphate is never allowed to stay below set limits.

In these plants, the amount of phosphate being used varies due to operating conditions. In boilers operating at pressures of 250 lb. or lower, the phosphate is kept over 40 parts per million (about 2 grains per gallon), soluble PO_4* in the boiler water. Where boilers operate at a higher pressure but keep the alkalinity below 1300 parts per million (about 75 grains per gallon), the soluble PO_4 is also kept over 40 parts per million. In event the alkalinity increases, the phosphate is increased about 20 parts per million for each 400 parts per million increase in alkalinity.

*All concentrations of phosphate are expressed as soluble PO_4 and are determined by methods which are not affected by the probable form in which the phosphate exists.

Maintenance of soluble phosphate is contingent on the fact that calcium, if it is allowed to enter the water, will remove the phosphate. Calcium salts will often reach the feedwater through the treated water or condenser leakage. It is interesting to note that, in one plant where 15 lb. of phosphate is added per day, 13 lb. reacts with the calcium which passes a zeolite softener and the calcium which enters as condenser leakage, thus leaving only 2 lb. to be effective for prevention of embrittlement.

Plants have been investigated where water treating companies have recommended the use of phosphate to prevent embrittlement. These recommendations have been based solely on the published laboratory tests and have given no consideration to the effect of calcium salts on the maintenance of soluble phosphate. One such plant was advised to add 1 lb. of phosphate salt per day to prevent embrittlement with an alkaline concentration of 2400 parts per million, (about 140 grains per gallon). The phosphate necessary to precipitate the calcium alone in the feedwater was 9 lb. per day, consequently, the boilers would have no protection whatsoever. This plant had never been told to maintain soluble phosphate in the boiler water at all times. Thus, the most essential part of the phosphate treatment had been lost sight of.

The longest boiler test on phosphate treatment is not over a year's duration. It would be advisable, therefore, to wait until these boilers have operated over longer periods before recommendation of phosphate treatment to prevent embrittlement is made. In the meantime, the plants under observation are being closely watched.

Organic Treatment

Laboratory tests have shown that tannate and acetate are helpful in inhibiting embrittlement. Various plants using tannin treatment where the sulphate ratio is not being maintained are also being closely watched. These plants cannot have the water checked daily for organic material or tannin; consequently, it is difficult to set any definite figures for the amount of organic matter to be fed. In one boiler test run to determine how the organic matter concentrated in the water, it was found that the amount of organic matter in the feedwater bore no relation to that in the boiler water. Because of this fact it was considered inadvisable to depend on tannin in this plant to prevent embrittlement.

Much work must be done in laboratory tests, pertaining to the influence of organic matter as well as the identification of organic matter in the boiler waters, before any definite hope can be given for the use of organic matter to prevent embrittlement.

Alabama Power Co., Birmingham, Ala., a subsidiary of the Southeastern Power & Light Co., will carry out a new power project at Mobila, Alabama, under the direction of the Southeastern Production Co., a recently organized subsidiary. The new plant will be at Hog Bayou and will be designed for an initial capacity of 10,000 hp. It will be used largely for supplying steam and power to the kraft paper mill of the International Paper Co., New York, now under construction at Mobile. Work on the power station will begin at once by the Dixie Construction Co.

Fremont Plant Tests Show Good Operation

MUNICIPAL LIGHT AND WATER DEPARTMENTS AT FREMONT, NEBRASKA, BUILD NEW PLANT. ONE 605-HP., 350-LB. BOILER WITH ECONOMIZER AND AIR HEATER AND ONE 2500-KW. TURBINE INSTALLED. COMPLETE COST AND TEST DATA GIVEN. BY C. F. LAMBERT*

ESTABLISHED by the city of Fremont, Nebraska, in 1885, the original water plant was built in the heart of the city, because water could be obtained from wells there as well as elsewhere while, from the standpoint of water distribution, the center of a city is the logical place for a water plant. Such matters as fuel and condensing water were not given great consideration at that time.

About the same time, an electric light plant was built by private capital. In 1895, some dissatisfaction as to rates and service came up, so $20,000 was voted to construct a municipal light plant for street lights only. Because of an insistent demand by the citizens for individual service from this plant, a commercial load was gradually developed. Eventually a further bond issue of $50,000 was voted for a larger plant and the plant, put in operation in 1907, was fully loaded in one year. This bond issue, together with interest, has since been paid for with all further extensions paid for out of earnings of the plant.

In 1909, the private light plant was purchased by a large operator of public utility properties and to a large extent the city officials attribute the further successful operation of the municipal plant to the keen competition with this company. It helped them realize the necessity of careful management and a close supervision of all operations. In 1921, the private company succumbed to this careful management and sold its distribution system to the city for $25,000, profits from the new customers paying for it in 8 mo. This gave the city a monopoly of the business, but the same careful operation was maintained.

LOAD GROWS SO FAST THAT NEW EQUIPMENT IS ALWAYS LOADED

Profits earned by the plant went back to the citizens, both in enlargement of the plant and reduction of rates. It is interesting to note that as rates were reduced profits were never decreased, because the customers appreciated the lower rates and availed themselves of the opportunity by using more current. This necessitated continuous enlargement of the plant, paid for as always out of the earnings.

In 1924, $100,000 was spent in improvements but by 1926, the equipment was again taxed to its utmost capacity. From 1921, when the private plant was taken over, up to 1926, the plant capacity had been increased from 1406 to 3281 kv-a. and the output from 2,800,000 kw-hr. to 5,600,000 kw-hr. per yr., the largest unit, 1875 kv-a., frequently being overloaded at peak periods. Figure 1 shows the growth of the system for the ten years between 1917 and 1927.

It will be recalled that, earlier in the article, mention was made of the location of the water plant in the center of the city. The light plant when built was, of course, combined with the water plant. As the load increased, the condensing water and fuel problems began to thrust themselves forward. Fremont is in the Platte River bottom, and an ample supply of good water can be obtained from 8-in. wells drilled to a depth of 40 to 50 ft. There was no need of a spray pond because the supply of cool water was ample. The big problem was

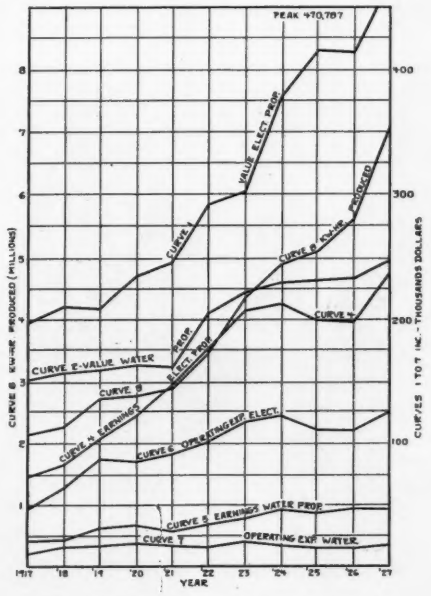


FIG. 1. THE ELECTRIC LOAD OF THE PLANT HAS INCREASED 700 PER CENT IN TEN YEARS

to get rid of the water. At first, it was emptied into the city sewers. Later, a large concrete storm sewer was constructed to help carry away this large volume of water.

In 1926, the Board of Public Works, a board of three business men entirely separate from, but appointed by, the City Council, decided to investigate thoroughly the question of further expansion. The Burns & McDonnell Engineering Co. of Kansas City, which had been handling all their engineering problems, was asked at this time to investigate the feasibility of moving the plant to another location, and also study the needs of the future. The engineers' report showed that there would be many advantages in having the plant moved but the judgment at that time was that these advantages were outweighed by the greater immediate financial outlay necessitating a bond election. It was therefore decided to enlarge the existing plant out of the surplus.

Property on which the plant is located was large enough for considerable extension, the main object being the disposal of condensing water and the absence of

*Burns & McDonnell Eng. Co., Kansas City, Mo.

TABLE I. DETAILED BUILDING AND EQUIPMENT COSTS OF FREMONT PLANT

BUILDING	
Bonds and Insurance	$ 2,145.00
Excavation and wrecking old building and boiler	5,100.00
Concrete complete, incl. forming and piling	12,947.98
Common brick work	7,455.70
Face brick	1,800.00
Metal Lath and Plastering	675.00
Glass and Glazing	460.00
Roof and Ceoltex Insulation	1,370.00
Painting	1,200.00
Cut Stone	2,993.00
Reinforcing Steel	1,900.00
Electric Wiring	1,406.23
Federal Tile	1,685.00
Plumbing	1,880.00
Underpinning	2,006.92
Fenestra Metal Sash	1,427.25
Structural Steel	28,813.84
Smoke Stack	3,046.40
Trilock Grating	2,361.72
Miscellaneous	3,886.36
TOTAL BUILDING	$84,510.40
BOILER ROOM EQUIPMENT	
1 605-hp. 350-lb. Murray boiler	$15,528.00
Brick work and erection	4,960.80
1 6-retort, 25-tuyere Taylor stoker	8,988.00
Erection	750.00
1 864-sq.ft. Foster economizer	5,765.00
Erection	450.00
1 3360-sq.ft. Sturtevant air heater	2,623.75
Erection of air heater	$ 350.00
1 Foster convection superheater	3,000.00
Beaumont coal and ash handling equip.	13,450.00
Erection	4,094.00
Elliot Deaerator	2,572.00
Montgomery electric elevator	2,600.00
Steam piping, Crane Co. pipe & fittings, Chapman valves	7,695.67
Ash car, track, turntable, etc.	920.00
Johns-Manville insulation and duct work	4,249.00
Worthington feed pumps, 12 by 7½ by 15	3,400.00
Buffalo and Sturtevant fans complete	2,934.25
Instruments, Bailey, Brown, Hayes & Tycos	2,000.00
TOTAL BOILER ROOM EQUIPMENT	$86,330.47
TURBINE ROOM EQUIPMENT	
1 General Electric 2500-kw. 300-lb. 2300-v. turbo generator with air cooler	$48,680.00
1 Worthington 4200-sq.ft. surface condenser with auxiliaries	10,396.00
1 10-ton Whiting Crane	3,045.00
Turbine Foundation	3,392.91
TOTAL TURBINE ROOM EQUIPMENT	$65,513.91
Building	$84,510.40
Boiler Room Equipment	86,330.47
Turbine Room Equipment	65,513.91
TOTAL CONSTRUCTION COST	$236,354.78
Engineering	10,483.10
TOTAL COST	$246,837.88

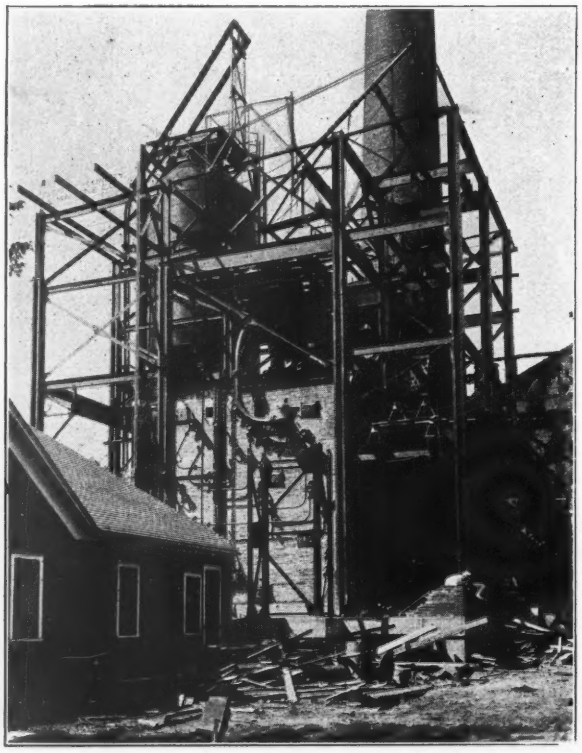


FIG. 2. COAL IS ELEVATED TO A CYLINDRICAL BUNKER BY A SKIP HOIST

switching facilities. It was decided not to attempt to follow the architectural design of the old building but to design a new section through the boiler and turbine room, making this entirely modern. The addition has been built at one end of the existing plant and so arranged that where future extensions are necessary the construction can be carried back over the old plant. A large brick stack located inside the old plant was not large enough for the new equipment. Consideration was given to the possibilities of a new and larger brick stack but it was found to be more economical to install a metal stack, supported above the boiler and large enough to take the capacity of one additional boiler. An innovation was made in this stack in that it is built entirely of genuine wrought iron. We believe that this is the first stack of this size for boiler plant service to be built of this material.

New equipment in the boiler room, shown in Figs. 2 and 3, consists of one 600-hp. boiler, equipped with superheater, air preheater and economizer and fired by an underfeed stoker. The boiler and other equipment is supported directly on the building steel work and the steel has been erected to permit the addition of a future similar boiler. The boiler room is about 65 ft. high from basement to roof, with an electric elevator furnished to permit easy and convenient access. Steel

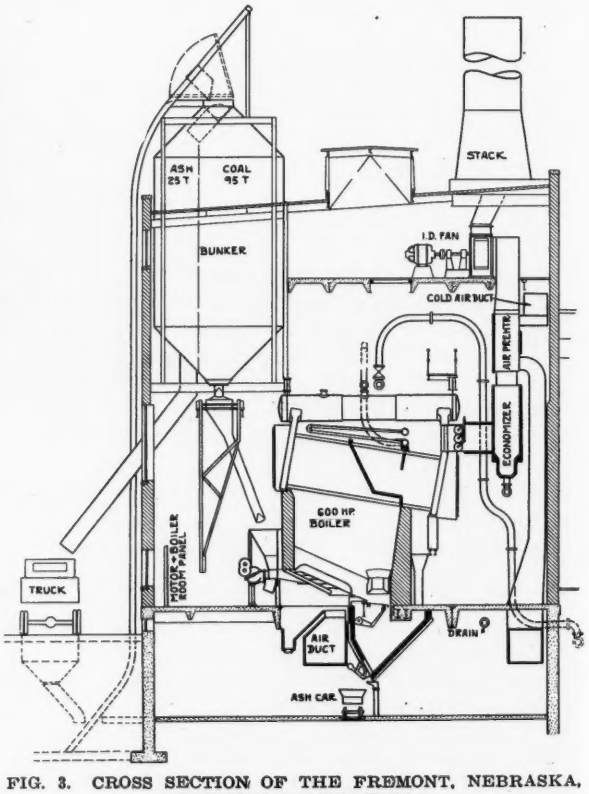


FIG. 3. CROSS SECTION OF THE FREMONT, NEBRASKA, MUNICIPAL BOILER ROOM

stairways with platform gratings at necessary places are also supplied. The draft fans and controls are located on the platform above the boiler. The forced draft fan has a capacity of 23,800 c.f.m. at 5½ in. static pressure. It is driven by an 1800 and 900-r.p.m., 40-hp. motor with push button control. The induced draft fan has a capacity of 26,500 c.f.m. and is driven by a 40-hp. motor. The boiler room is 48 ft. by 52 ft. by 65 ft. high. The turbine room is 57 ft. by 29 ft. by 53 ft. high. The frame work is steel with brick walls and concrete and tile roof. The generating equipment consists of one 2500-kw. turbine unit set over a 4200-sq. ft. surface condenser.

Completed Cost Less Than $100 per Kw. of Capacity

Costs of the complete project, set forth in detail in Table I, show a total expense of $245,837.88 which includes building equipment and engineering expense.

After completion of the plant, acceptance tests were run on all equipment. Both boiler and turbine tests are tabulated in detail in Table II. The boiler and its auxiliaries together with the turbine and condenser were isolated from the rest of the plant and tested at the same time. It was desired that the test be as accurate as possible under field conditions and about 25 observers were used. The plant is unusually well equipped with flow meters, indicating and recording instruments and thermometers. In addition to the regular instruments, new watt and watt-hour meters, with new instrument transformers were used. The watt meters and instrument transformers were sent back to the factory for calibration after the test with the same hook up as during the test. Pressure gages were checked with a dead weight tester before and after the test. Thermometers were calibrated and instruments in general, checked in accordance with the A. S. M. E. test code.

TABLE II. BOILER, TURBINE AND CONDENSER TESTS ARE ALL WELL WITHIN THE GUARANTEES

BOILER TESTS				
Boiler heating surface			6,050	sq.ft.
Superheater surface			1,782	" "
Economizer surface			864	" "
Air heater surface			2,478	" "
Grate surface			123.3	" "
Fuel burning equipment			Stoker	
Fuel	Slack & 3/4 in. Screenings		Mixture Kansas & Illinois	
Volume of combustion space			1,600	cu.ft.
Furnace, center of grate to nearest heating surface			11	ft.
Furnace volume per sq.ft. boiler heating surface			.27	cu.ft.
FUEL PROXIMATE ANALYSIS				
AS FIRED	A.E.CO.	NEB. UNIV.	DEARBORN CHEM.CO.	WEIGHTED AVE.USED
Volatile matter	33.31	30.83	28.30	30.72 per cent
Fixed carbon	45.43	45.40	44.83	44.84 " "
Ash	15.16	15.90	19.17	16.69 " "
Moisture	5.60	7.87	7.70	7.75 " "
Heating value per lb.	11,605	12,090	10,928	11,200 B.t.u.
CALCULATED FROM PROX. ANALYSIS				
FUEL ULTIMATE ANALYSIS	A.E.CO.	NEB. UNIV.	DEARBORN CHEM.CO.	CALC.AVER.
Carbon	60.5	61.20	58.60	60.1 per cent
Hydrogen	4.13	4.08	3.83	4.0 " "
Oxygen	8.6	7.19	6.98	7.5 " "
Nitrogen	1.2	1.24	1.20	1.2 " "
Sulphur	3.08		2.52	2.8 " "
Moisture	7.7	7.87	7.70	7.7 " "
Calculated B.t.u. (Dulong)	10,845	11,020	10,485 as fired	
GAS				
Gas Analysis, boiler outlet: Per cent CO_2				13.0
Dry gas per lb. fuel, boiler outlet (as fired)		Approx.calc.		11.69 lb.
Air supplied per lb. fuel, furnace (as fired)		" "		10.95 lb.
PRESSURES				
Steam pressure by gage, boiler corrected for height			286.3	lb.abs.
Steam pressure by gage at superheater outlet			negligible drop	
Air press. Windbox			+1.47	in.of water
Air press. in ashpit zone, at extension grate			+ .63	in.of water
Draft in furnace			-.09	in.of water
Draft at boiler outlet			-.20	in.of water
TEMPERATURE				
Steam temperature Indicating thermometer			544	deg.F.
Steam temperature Recording thermometer			558.4	deg.F.
Superheat			120.8	deg.F.
Temperature of air surrounding boiler, (T_1)			94.1	deg.F.
Temperature of air entering air heater, (T_2)			94.1	deg.F.
Temperature of air leaving air heater, (T_3)			199.4	deg.F
Temperature of air for combustion, (T_4)			199.4	deg.F
Temperature of gases leaving boiler, (T_5)			550.3	deg.F.
Temperature of gases leaving economizer (T_7)			380.8	deg.F.
Temperature of gases leaving air heater (T_8)			296.0	deg.F.
Temperature of feedwater entering boiler (T_9) Indic.			164.8	deg.F.
Temp. of feedwater entering economizer (T_{10})			102.8	deg.F.
HOURLY DATA				
Duration of test			8	hours
Fuel as fired per hour, average			3672	lb.
Dry fuel per hour			3390	lb.
Fuel as fired per sq.ft. of grate per hour			30	lb.
Fuel as fired retort per hour			612	lb.
Dry fuel per sq.ft. of grate per hour			27.5	lb.
Dry fuel per retort per hour			565	lb.
Combustion space per lb. coal per hour (as fired)			.436	cu.ft.
Refuse per hour, calculated			720	lb.
Actual water per houf, weighed			29,004	lb.
Steam by flow meter			29,048	lb.
Factor of evaporation			1.184	lb.
Equivalent evaporation per hour			34,341	lb.
Units of evaporation			33,324.5	U.E.
Boiler horsepower, average			995	H.P.
REFUSE		A.E.CO. N.U.	AVERAGE	
Refuse, per cent of fuel (as fired)			19.63	per cent
Percentage of combustible in refuse		16.28 14.06	15.17	per cent
Carbon burned per lb.,fuel (as fired)			.571	lb
Actual evaporation per lb.fuel (as fired)			7.91	lb
Equivalent evaporation per lb.fuel (as fired)			9.36	lb.
Equivalent evaporation per sq.ft.heating surface per hr.			57.85	lb.
Units of evap.absorbed,sq.ft. of boiler heating surf/hr.			5.51	U.E.
Percentage rating			165	per cent
EFFICIENCY				
Efficiency of boiler,superheater, furnace, grats and air heater - per cent				81.1
Comp. eff. boiler, superheater, furnace and grate (not equipped with air heater)				78.7
Efficiency including economizer - per cent				85.0

TURBINE TESTS				
Test Number	1	2	3	4
Time	10:00to 11:00AM	3:00to 4:00PM	4:30to 5:30PM	5:45to 6:45PM
Gross output generator, kw.	1997	2005	1197	630.2
Kw. used by separate exciter	18	18	15	13.4
Net output of generator, kw.	1979	1987	1182	616.8
Total turbine wheel kw. (calc.)	2134	2143	1321	749

TURBINE TESTS (CONTINUED)				
Throttle press., lb. per sq. in. abs.	286.3	284.8	287.4	296.6
Ave.superheat, deg.F.	64.8	86.1	61.1	25.0
Power factor	.822	.828	.880	.872
Net condensate, lb.per hr.	25409	24958	16122	10302
Speed, r.p.m.	3600	3600	3600	3600
Test steam rate, lb. per kw.hr.	12.79	12.58	13.62	16.75
Correction factor for superheat (100 deg. = 8.5 per cent)	.9276	.946	.9245	.894
Correction factor for exhaust pressure (8 per cent per in. at 2000 kw. 9 per cent at 1250, 10 per cent at 625)	1.015	1.014	1.031	1.018
Correction factor for main press. (Based on available energy)	.999	.998	.999	1.004
Correction factor for power factor (Correc. from 80 per cent to 100 per cent = .5 per cent in gen.eff.)	1.0006	1.0007	1.002	1.002
Test steam rate corrected, lb./kw.hr.	12.02	12.05	13.06	15.31
Corrected test flow, lb./hr.	23788	23943	15378	9443
FROM CURVE				
Kw. load	625	1250	1375	2500
Corrected flow from curve, lb.	9500	16075	22700	29300
Corrected steam rate, lb.per kw.hr.	15.20	12.83	12.10	11.72
Contract steam rate, lb. per kw.hr. (275 lb.ga. 150 deg.F. 1.5 in.hg.abs. .80 per cent PF)	14.70	12.80	12.10	11.80
STEAM AIR EJECTOR - 15 CU.FT.CAPACITY				
Abs.steam press. at ejector	283.7	173.1	167.1	169.1
Ave.superheat deg.F.	65	110	86	48
B.t.u./lb. of steam at ejector	1247.5	1259.1	1245.4	1221.9
Heat of condensed steam	96.0	80.0	90.0	111.7
B.t.u. released in condensing	1151.5	1179.1	1155.4	1110.2
B.t.u. used in doing work, est.4%	46.1	47.2	46.2	44.4
B.t.u./lb. steam removed by cooler	1105.4	1131.9	1109.2	1065.8
Temp. cooling water (condensate) in	85.2	83.0	91.2	87.0
Temp. condensate out	128.0	112.0	122.0	143.7
Temp. rise	42.8	29.0	40.8	56.7
Quantity cooling water, lb./hr.	26261	25418	16618	10754
Steam used lb./hr.				
Calc. from temp. rise	1018	651	612	572
Calc. by Manufacturer	883	525	516	534
Calc. from nozzle areas (used)	960	569	559	581
SURFACE CONDENSER TESTS				
Abs. corrected pres. exh.flge.	1.31	1.32	1.15	1.32
Corresp. sat. steam temp.	87.5	87.7	82.5	87.7
Barometer readings in.hg.	28.77	28.67	28.64	28.61
Corr. sat. temp. of barometer deg.F.	92	93	95	93
Total weighed condensate lb./hr.	26251	25408	16608	10744
Tank and valve leakage (add)	10	10	10	10
Ejector steam (subtract)	960	569	559	581
Condenser leakage (subtract)	12	12	12	12
Net steam entering condenser	25289	24837	16047	10161
Steam rate lb./wheel kw.hr.	11.85	11.59	12.15	13.57
Circ. water inlet deg.F.	54	54	54	54
Circ. water outlet deg.F.	84.2	82.6	80.4	86
Circ. water temp. rise	30.2	28.6	26.4	32
Temp. of condensate in hotwell	85.2	83	81.2	87
Total water del.by hotwell pump lb./hr.	26261	25418	16618	10754
B.t.u./lb. of steam at throttle	1247.5	1259.1	1245.4	1221.9
Heat used to do work B.t.u./lb. = 3413 ÷ wheel water rate	288	294	281	252
Radiation B.t.u./lb.	1	1	2	2
Heat in lb. of steam condensed	958.5	964.1	962.4	967.9
Heat of liquid in hotwell	53.5	51.0	49.1	55
Heat abs. by cooling water	905.0	913.1	913.3	912.9
Sq.ft. surface condenser	4200	4200	4200	4200
Heat in ejector condensate B.t.u./lb.	42.8	29.0	40.8	56.7
Ejector condensate flashed lb./hr.	960	569	559	581
M B.t.u./hr. removed by condenser	22928	22695	14679	9309
Tube veloc. ft./sec.	2.61	2.75	1.92	1.03
HEAT TRANSFER				
Temp. rise water test conditions	30.2	28.6	26.4	32
Terminal diff. on test deg.F.	3.3	5.1	2.1	1.7
Arith. mean temp. diff.	18.4	19.4	15.3	17.7
Logarithmic temp. diff.	13.1	15.1	10.1	10.7
Arith. heat trans. B.t.u./sq.ft/hr./deg.F.	297	279	228	125
Log. heat trans.B.t.u./sq.ft./hr./deg.F.	417	358	345	207
GUARANTEE COMPARISON				
Cooling water g.p.m.	2900	2900		
Tube veloc. ft./sec.	5	5		
Abs. press.	.925	.915		
Test temp. rise corr. to 2900 g.p.m.	15.8	15.2		
Terminal diff. to secure above abs. press. using with 2900 g.p.m.deg.F.	7.7	7.4		
Arith. heat transfer to secure above abs.press. with 2900 g.p.m.	350	355		
Coef. C (B.t.u. = CTV) from test	184	168		
Heat transfer based on test coeff. and 5 ft./sec.vel.	411	376		

Boiler forced and induced draft fans are driven by variable speed slip ring motors controlled by push buttons. Air is taken from inside the roof and forced down through the air preheater, the economizer and to the underfeed stoker. All controls are grouped at a panel in front of the boiler.

Stoker efficiencies were arrived at by giving proper weight to the various test results which we believe to be most reliable. For instance, the fuel sample sent to the stoker manufacturer for analysis showed 5.6 per cent moisture whereas all previous samples which were analyzed without delay showed 7.7 per cent moisture. Again, from calculating the available B.t.u. per lb. of coal as fired, using Dulong empirical formula, we are led to believe the University of Nebraska, coal analysis was 500 B.t.u. too high. Thus we arrived at the figure

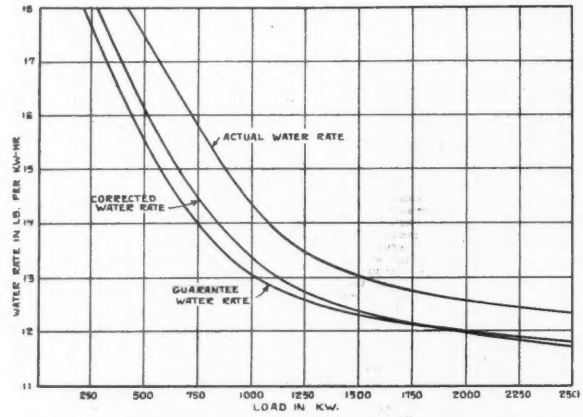


FIG. 4. TURBINE AND CONDENSER TEST RESULTS REPORTED IN TABLE II

11,200 B.t.u. as the correct one. As a result, we calculate the efficiency for boiler, superheater, furnace and grate was 78.7 per cent, whereas the stoker manufacturer guaranteed 78 per cent for 165 per cent rating. The efficiency when the air heater is added to the above is 81.1 per cent and when the air heater and economizer are both added, was 85.0 per cent. The various manufacturers estimated (not guaranteed) the overall efficiency at this rating at 86.2 per cent.

In the results, we have given more value to indicating thermometer readings than for recording thermometer. The recording thermometer reading flue gas temperature between the economizer and air preheater is reading about 20 deg. F. too low. The inlet water temperature to the economizer during the test was considered as 111.4 deg. F. The economizer produced a rise in the feedwater temperature of 53.4 deg. F., whereas the manufacturer guaranteed 47 deg. F. rise.

The air preheater produced a rise in the temperature of inlet air of 105 deg. F., as compared to the estimate of 129 deg. F. The final gas temperature was 199.4 deg. F. and this was the controlling factor, as the preheater was purposely kept sooted. The superheat was 130.8 deg. F. by the indicating thermometer, 145.2 deg. F. by the recording thermometer. The manufacturers' guarantee was 140 deg. F. for 165 per cent rating with not more than 1 per cent moisture in the steam. It was our opinion that moisture was coming over and a steam purifier was needed.

Turbine and Condenser Tests

At the turbine exhaust, the absolute pressure was recorded by two mercury vacuum columns and one mercury absolute pressure column. No bleeding took place from the turbine. All condensate from the hot well was passed through the inter-after condenser of the air ejectors and from there to the weigh tanks bypassing the heater and the deaerator. The heater was bypassed during the test to prevent troubles from steam arising from the open weigh tanks that would have taken place with hotter water.

Two condensate weigh tanks and one cold water make-up weigh tank were used. They discharged into a receiving tank which acted as a reservoir over the boiler feed pumps. The make-up water was due to the steam used by the boiler feed pump being discharged back to the heater which was of course connected to the regular plant system. The arrangement of tanks made it possible for one operator to weigh the water into the boiler and the condensate out of the condenser. The steam flow meters recorded the boiler evaporation checked within 0.15 per cent of the weighed evaporation. Coal to the stoker hopper was weighed from a weigh larry.

Loads on the boiler, turbine and generator were held constant by use of a water rheostat in conjunction with the daily load. This load was held constant from 8 a. m. to 4 p. m. at approximately 2000 kw. and then shifted to 1200 kw. between 4:30 and 5:30 p. m., then dropped to 625 kw. between 5:45 and 6:45 p. m.

It was necessary to correct the test results of the turbine to the contract conditions. The correction factors for exhaust pressure, main pressure, superheat, and power factor are listed in the test data. It will be noted that the guarantees were fulfilled except at ¼ load. In view of this test being for a one-hour period, we did not give it the same weight as for tests Nos. 1 and 2 where the unit was held steady for 8 hr.

In spite of the quarter load test showing higher than the guarantee, it is lower by 0.6 lb. than the quarter load quarantee of any other competitive turbine offered to the city. A further test at the quarter load over a longer period, with possibly some adjustments, would probably have shown a lower steam rate.

Low superheat at the turbine was attributed to moisture coming over with the steam through the superheater, although it is possible that the total temperature of the steam at the turbine was read slightly low, since the thermometer well was 3 in. long instead of a 6-in. finned A. S. M. E. standard.

The condenser was not tested under contract conditions either, as it was impossible to circulate the full 2900 g.p.m. of cooling water due to non-completion of a sewer. The engineer's specifications required that the condenser produce a vacuum of within 1¼ in. absolute when condensing 32,000 lb. of steam per hour with 2900 g.p.m. of 55 deg. F. water. The manufacturer guaranteed a vacuum of 1.156 in. abs. under those conditions. By interpolation, it was found that under test conditions No. 1 the manufacturer estimated that the vacuum should be 0.925 in. abs. and for test No. 2 0.915 in. abs. although no guarantees were made for less than 1 in. abs.

Terminal difference between steam space and outgoing water ranged from 1.7 to 5.1 deg. F., a good performance in view of the usual 10 deg. F. The temperature rise of the circulating water ranged from 26.4 to 32 deg. F., which is also good when the low velocities are considered. The quantity of circulating water was calculated from the temperature rise.

In figuring the heat removed by the condenser, it was necessary to take into account the heat in the steam flashed from the inter-after cooler condensate returned to the hot well.

To check the test results with the guarantees, several assumptions were made, all of which seem to be on the safe side.

First, that if 2900 g.p.m. of water were circulated at a 5-ft. velocity, the same total amount of heat would be removed. On this basis, the temperature rise for test No. 1 and test No. 2 becomes 15.8 and 15.2 deg. F. compared to 30.2 and 28.6 on test.

Second, that using the manufacturers' expected absolute pressures, namely 0.925 and 0.915 in., and the foregoing temperature rise, a terminal difference of 7.7 and 7.4 deg. F. would be required. This seems a fair assumption in view of those obtained by the test.

Third, arithmetical heat transfer necessary to obtain the above absolute pressure and terminal difference would be 350 and 355 B.t.u. respectively on tests Nos. 1 and 2. The actual arithmetical heat transfer obtained on the test was 297 and 279 B.t.u. Solving for C in the equation B.t.u. $= C \sqrt{\text{velocity}}$ gives values of C of 184 and 168 respectively for the test velocities.

Applying these same values of C for the 5 ft. per sec. velocity gives heat transfer values of 411 and 376 B.t.u. as what the test would indicate the condenser would do when supplied with the proper amount of water.

Since the values 350 and 355 only were needed to meet the guarantees, it would seem that the condenser complied with the guarantees. The air ejector was operated at far in excess of its normal working steam pressure, as it was not considered desirable to have any possible trouble from air leaks during the condenser test.

CAPACITY of the Riverside plant of the United Light and Power Co. at Bettendorf, Iowa, will be more than doubled upon completion of a $1,400,000 investment program announced for that unit by R. B. McDonald, president of the local subsidiary companies of the concern. Work is scheduled to begin February 1 and will require 7 mo. Contract for a 30,000-hp. turbine-generator has been negotiated with the Allis-Chalmers Manufacturing Co. Rapid expansion of industrial concerns in the territory served by the plant, chief among which is the International Harvester Co., necessitated the expansion of the plant, originally designed three years ago.

NOVEMBER SALES of mechanical stokers, as reported to the Department of Commerce by the 10 leading manufacturers in the industry, totaled 116 under 30,938 hp. of boilers. Of this number, 54 stokers were installed under fire-tube boilers of 8360 hp. and 62 stokers under water tube boilers of 22,578 hp.

Pulverized Coal Furnace and Burner Design Inseparable

THERE IS AN intimate and inseparable relation between the burner and the furnace of pulverized coal installations and both are passing together through an intensive stage of change and improvement, according to E. G. Bailey, in a paper read before the Second National Fuels Meeting of the A. S. M. E.

Now that water-cooled furnaces of various types have been extensively tried out and their characteristics and limitations are becoming fairly well defined, we know that furnaces can be built to accommodate almost any type of burner. Therefore, the logical sequence in development is to concentrate upon the improvement of pulverized fuel burners and then design the size, shape and wall construction of the furnace to suit the burning equipment.

The ideal burner is one by means of which the combustion of fuel is completed within a minimum of furnace volume and with a reasonably low excess air. Pulverized coal is more difficult to burn than gas or oil, because it is not usually pulverized to an equivalent degree of fineness; it cannot be fed or forced into the furnace by itself but must be carried in mixed with air; most particles of coal adhere together, making the equivalent to coarser coal; only the volatile matter is burned in the gaseous state, leaving 50 to 90 per cent of the fuel to be burned as solid carbon floating in an atmosphere of gas and air with oxygen varying from less than 20 per cent down to 1 or 2 per cent and it requires a higher ignition temperature.

MANY CONDITIONS MUST BE MET BY GOOD BURNER

Specifications for a good pulverized fuel burner are: (1) It must deliver to the furnace coal uniformly distributed throughout the primary or carrying air; (2) the secondary and primary air streams should impinge against each other upon entering the furnace so that the coal is further distributed uniformly throughout all of the air for combustion; (3) the velocities and directions of the different streams of air should be such that the resultant flame will be broken up into eddies and unequal jets to induce turbulence and mixing, and the flame velocity should not be excessive; (4) the burner parts should not collect coke, or if they do, they should be easily cleaned.

The function of the burner itself is merely the mixing of the coal and primary air with the supplemental or secondary air as they enter the furnace at the proper velocity. Before any burner can be properly designed and operated, the following factors must be controlled or allowed for: Fineness of coal; surface moisture in coal; volatile matter in coal; method and place of mixing coal with primary air; path which mixture of coal and primary air take from point of mixture to burner; relative amount of primary air; and the furnace, its shape, size and temperature.

The finer the coal is pulverized the simpler the problem of delivering it to the burners as well as burning and handling it to the furnace; however, there is a limit to the cost of pulverization which should be taken into account.

Diesel-Driven Power, Light and Ice Plant

TEXAS-LOUISIANA POWER CO. INSTALLS TWO 1250-HP. NORDBERG ENGINES IN PLANT DESIGNED FOR FIVE UNITS. SEPARATELY OPERATED ICE PLANT IN SAME BUILDING

TO TAKE CARE of the rapidly growing power load in the vicinity of Pecos, Texas, including new oil fields to the north and east, the Texas-Louisiana Power Co. built a new Diesel engine-driven power plant with an installed capacity of 1800 kw. and an ultimate capacity of 4500 kw.

This plant, shown in Fig. 1, is of brick and steel construction. In addition to the power plant, it houses a 50-t. ice plant, which, although it is in the same building with and owned by the same company, is independent of the power plant operation except in relation to the power supply.

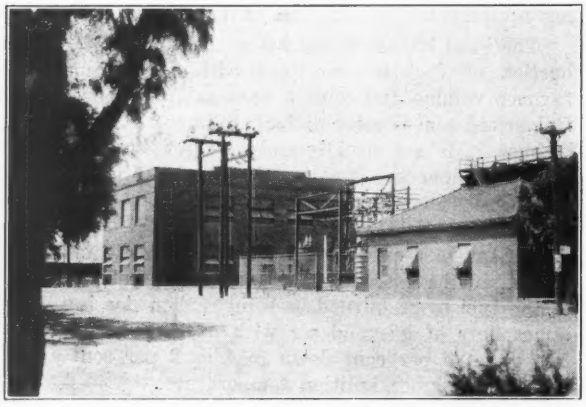


FIG. 1. POWER HOUSE, SWITCHYARD AND OFFICE AT PECOS, TEXAS

Two 1250-hp., 180-r.p.m. Nordberg engines direct connected to General Electric 2300-v., 3-phase, 60-cycle, 80-per cent power factor, 900-kw. generators are installed. Each unit has a direct-connected 22-kw., 125-v. exciter. Electrical distribution and control is handled through a Westinghouse 14-panel black slate switchboard, upon which in addition to other instruments, are mounted a General Electric voltage regulator and a Bristol recording voltmeter. In the summer, peak loads run between 1200 and 1400 kw.; the two peaks coming about 12 noon and eight in the evening, are almost equal. During May, 1928, they generated 579,000 kw-hr.

CLOSED COOLING SYSTEM USED

One of the interesting features of the plant is the closed system of jacket cooling water and the method of guarding against failure of this supply. The Fluor redwood cooling tower is shown in the photograph, Fig. 3C, and in detail in Fig. 2. Raw water is pumped to the top of the tower by two 600-g.p.m., 60-ft. head De Laval centrifugal pumps driven by General Electric 1750-r.p.m., 220-v., 3-phase, 60-cycle induction motors. At the top of the tower the water is distributed and then cooled as it falls from deck to deck.

At the base of the tower, there is a collecting system which runs the water into a longitudinal flume. Through gates in this flume, the water flows to the various distributing racks over each stand of cooling sections. Here the water is again distributed and falls down over the Griscom-Russell bent tube heat exchanger as shown in Fig 4. These sections have 1-in. Admiralty tubes.

By adjusting the gates in the flume, the amount of water flowing over each section can be regulated as desired. The jacket water, circulated normally by two 506-g.p.m., 35-ft. head DeLaval centrifugal pumps driven by General Electric 1750-r.p.m., 220-v., 3-phase, 60-cycle induction motors, flows through the tubes in a closed system. The makeup required is small so that this water can be maintained pure and the formation of scale in the jackets eliminated

TURBINE-DRIVEN PUMP CONTROLLED AUTOMATICALLY

In order to protect the engines in case of failure of the motor-driven pumps, a standby pump driven by a 25-hp. DeLaval water turbine is installed. It is the third pump in Fig. 3D and is the same capacity and type as the other two. The Texas-Louisiana Power Co. also has the city water supply and maintains an elevated storage tank near the cooling tower. Water for driving the turbines is taken from this tank and in order to avoid waste the discharge is piped back to the base of the cooling tower.

This standby pump is controlled automatically by a spring loaded diaphragm control valve. When the pressure on top of the diaphragm, taken from the discharge of the motor-driven pumps, is reduced, the city water pressure on the bottom opens the valve and starts the turbine. All three of the pumps have Apco automatic primers and the motor-driven pumps all have push-button control. Two Bristol two-pen thermometers record the ingoing and outgoing jacket water temperatures.

In the same building is a 50-t. ice plant, the three Baker compressors being shown in Fig. 3E. The machine

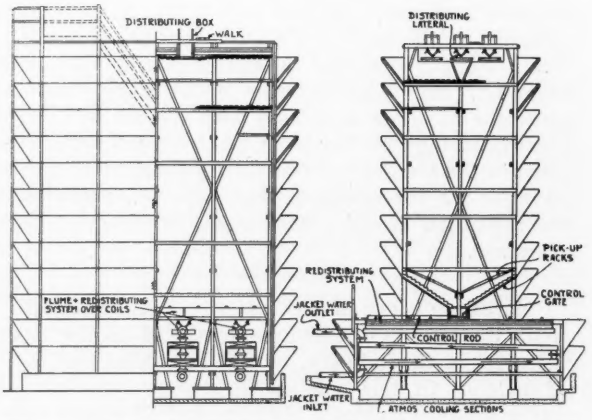


FIG. 2. DRAWING SHOWING THE ARRANGEMENT AND DESIGN OF THE COOLING TOWER

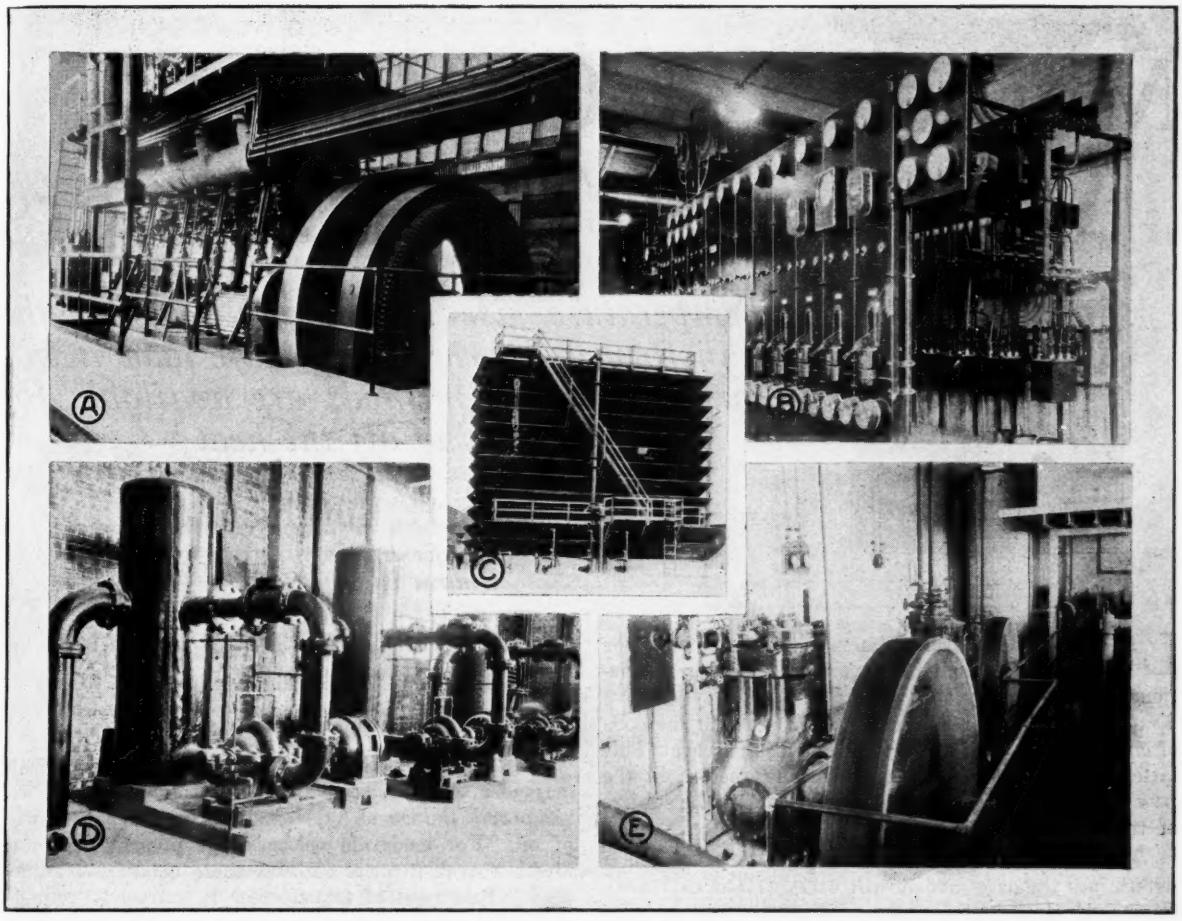


FIG. 3. MISCELLANEOUS VIEWS OF THE INTERIOR, A. ONE OF THE 1250-HP. ENGINES, B. THE 14-PANEL BLACK SLATE SWITCHBOARD, C. COOLING TOWER, D. JACKET WATER CIRCULATING PUMPS, E. MOTOR-DRIVEN ICE MACHINES

in the foreground is 9½ by 14 in. driven by a 50-hp., 2200-v., 690-r.p.m. General Electric motor, the second machine is 7¼ by 7¼ in. driven by a 30-hp., 2200-v., 640-r.p.m. Westinghouse motor and the third machine is 4½ by 4½ in., driven by a 10-hp., 1750-r.p.m., 220-v.

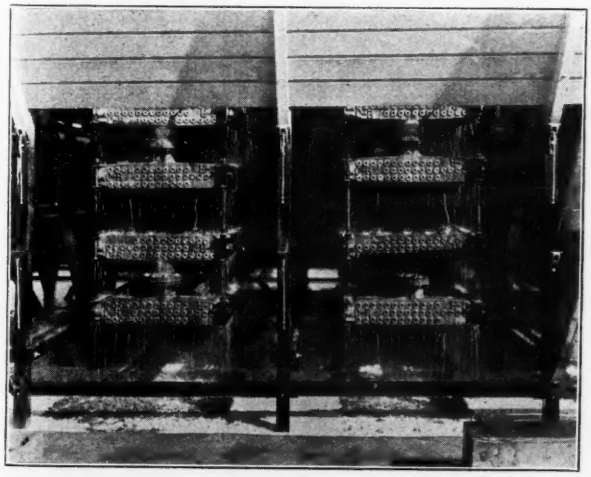


FIG. 4. JACKET WATER IS COOLED IN HEAT EXCHANGERS LOCATED IN THE BASE OF THE TOWER

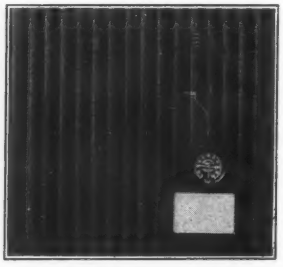
General Electric motor. All three use Lenix close belt drive.

Water is softened by the International Type J-22 water treater shown behind the compressors in Fig. 3E. The air agitator is a General Electric 350-c.f.m., 3-lb. pressure, 3500-r.p.m. centrifugal blower driven by a 220-v., 75-hp., 3600-r.p.m. General Electric motor. A Frederick core sucker pump with a capacity of 10 g.p.m. at 1750 r.p.m. is driven by a Lincoln 15-hp., 220-v. motor. This pump operates in conjunction with a Penberthy injector.

Additional equipment installed includes: A De-Laval 260-g.p.m., 60-ft. head brine circulator driven by a 7.5-hp. General Electric 220-v. motor; a vertical brine agitator driven by a Lincoln 2-hp., 220-v., 720-r.p.m. motor; a Victor three-cake ice dump and a Chisholm-Moore 1-t. crane. They have 138 300-lb. cans arranged 6 wide and 23 long.

BRITISH INDUSTRIES FAIR, organized by the British Government, will open at London and Birmingham, England on February 18, 1929. In general the Birmingham section will deal with hardware, machinery, automotive products and the like, while the London section covers practically every other industry.

Methods of Cooling Power Transformers



Temperature rise in various parts of the transformer determines the safe load it will carry. Various methods are available for carrying off the heat

By L. H. Burnham
Transformer Engineer
General Electric Co.

LARGE POWER transformers may now be built for almost any capacity and voltage. Former restrictions in the capacity and voltage of certain types have disappeared as the result of improvements in methods of construction, ventilation and dissipation of heat. This latter, which is one of the controlling factors in the power-carrying ability of all transformers, is the subject of this article.

Temperature rise in various parts of the transformer determines the safe load it will carry. It is extremely important that uniform and efficient cooling be provided and that all hot spots be avoided, not only in the core iron but also throughout the windings.

Transformers were at first cooled only by natural air draft but because of the obvious limitations, the natural air-draft cooling system was quickly superseded by other ventilating methods of much greater efficiency. Natural-draft transformers are still manufactured but in comparatively small capacities.

Air-Blast Transformers

In large cities, high land values demand rigid economy of space. In some localities, fire regulations will not permit the use of a device requiring large quantities of oil. For moderate voltages, the present design of air-blast transformers satisfies these conditions admirably. This type of transformer is extremely reliable, and gives very satisfactory service. It may be built in any capacity, single-phase and three-phase, for any frequency and voltage up to and including 27,500 v. Above this figure, it is not practicable to prevent corona.

All air-blast transformers use the shell type of core construction with the windings in the form of rectangular slab coils located vertically. This construction

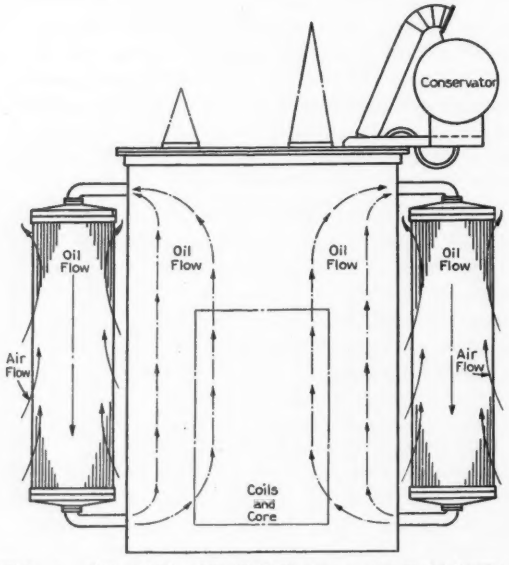


FIG. 1. OIL AND AIR FLOW IN A SELF-COOLED TRANSFORMER

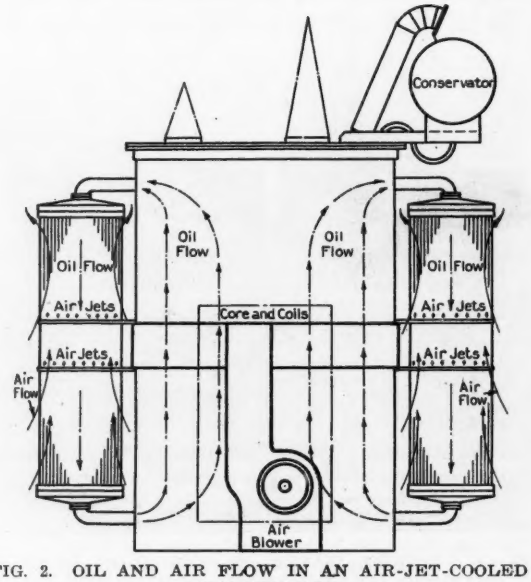


FIG. 2. OIL AND AIR FLOW IN AN AIR-JET-COOLED TRANSFORMER

lends itself to efficient air movement and eliminates the possibility of dead air pockets. Untaped coils are used so that there will be a rapid heat transfer from the windings to the cooling air.

Cooling air is sent into the transformer under pressures varying from ⅜ oz. per sq. in. in the smaller capacities, to 4 oz. per sq. in. in the largest capacity, the volume per minute required depending, of course, upon the total core and copper loss.

Comparison of the space required by the air blast transformer in relation to other types, is given with other data, in the following table.

5000-Kv-a., 13,200-Volt, 60-Cycle, 55-Deg. C. Transformer

	Water-Cooled	Self-Cooled	Air-Blast
Floor dimensions, in in.....	82 x 76	93 x 95	51 x 40
Floor space, sq. in.....	5530	7900	2040
Weight, in lb.....	31,500	35,000	19,500
Full-load efficiency, per cent.....	99.2	99.2	98.9
Approx. price, per cent.....	100	115	107

The largest air-blast transformers in physical size and capacity ever to be built are two soon to be installed by the New York Edison Co. Each transformer weighs 108,000 lb. and contains 20 mi. of conductor.

Oil-Immersed Transformers

Among the best methods of cooling and insulating transformers is by immersion in tanks of insulating oil. This method, in addition to providing a highly efficient means of removing the heat generated in core and windings, also permits closer spacing of the parts than is possible in air-cooled apparatus, because of the higher dielectric strength of the oil.

There are several types of oil-immersed transformers, classified according to whether the heat is removed from

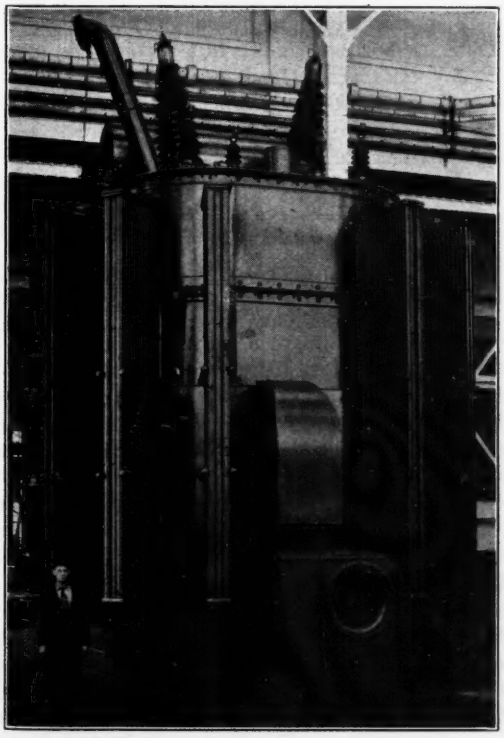


FIG. 3. A SINGLE-PHASE, 20,000-KV-A. AIR-PRESSURE TRANSFORMER, SELF-COOLED, RATING 12,000 KV-A.

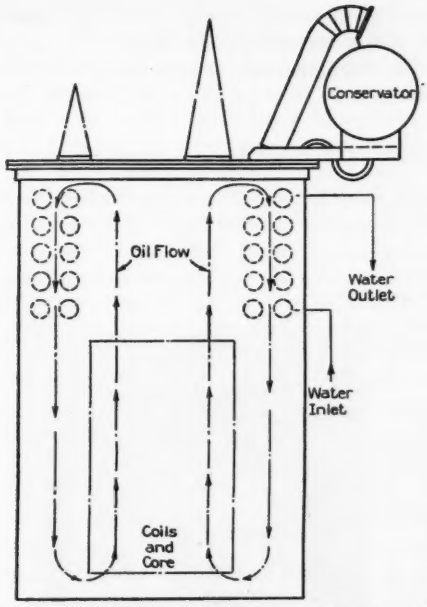


FIG. 4. OIL AND WATER FLOW IN WATER-COOLED TRANSFORMER

the oil by natural convection through the walls of the tank, or by forced cooling with air jets or water. These types will be taken up in order.

Self-Cooled Type

Most popular of the oil-immersed transformers is the self-cooled type. The method of cooling such transformers, if installed outdoors, is ideal, as a self-cooled unit requires little attention and has inherently lower losses than any other type, because of the use of lower working densities in active material, both copper and iron.

Self-cooled transformers are installed in tanks which have sufficient radiating surface to dissipate the heat without the use of artificial cooling. Heat is dissipated in this type of transformer in three ways: by conduction, by convection and by radiation. The oil receives its heat from the core and coils, and transfers it to the inner surface of the tank by convection currents, where it is transmitted by conduction through the metal to the outer surface of the tank.

The amount of energy that may be dissipated from a tank for a given temperature rise of oil depends upon the shape of the surface exposed to the air. A plain surface is the most efficient per unit of area, as the total surface is effective for radiation, whereas with an irregular surface, only the outside perimeter is effective for radiation and the total surface effective for convection. Where large capacities and relatively large amounts of heat are involved, special provisions for heat dissipation must be made.

Several methods are available for increasing the radiating surface of tanks for self-cooled transformers: i.e., the use of ribs, corrugations, tubes and radiators. The tubular tank is most often used for self-cooled power transformers, wherever radiating surface permits.

As the oil is heated, it passes upward through the coil ducts to the top of the tank, and enters the tubes. Here it is cooled by contact with the surfaces of the

tubes and subsequently settles and passes back into the tank at the lower ends of the tubes.

In the tubular tank design, the radiating surface with one row of tubes is about 75 per cent as effective as the surface of a plain steel plate tank and the efficiency decreases rapidly with every additional row of tubes.

When very large self-cooled transformers are built, they are placed in radiator tanks, for the radiators may be removed for shipment. Such tanks are equipped with radiator valves which permit removal and assembly of

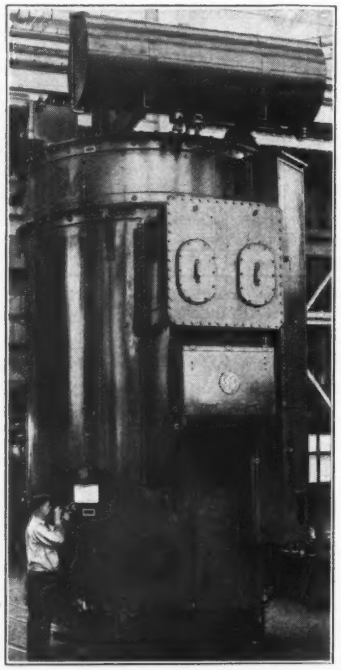


FIG. 5. A SINGLE-PHASE, 20,000-KV-A., WATER-COOLED TRANSFORMER

The cooling coil inlets and outlets are enclosed in steel housings at the right.

radiators without draining the oil from the main transformer tank. When space limitations are such that it is impossible to mount the radiators around the periphery of the tank, the radiators required may be assembled in banks, the oil inlet and oil outlet from the radiator bank being connected to the main transformer tank by suitable oil ducts. With this arrangement, self-cooled transformers of practically unlimited size may be produced. This scheme is especially applicable when it is desired to install the main tank of the transformer in a cell with the radiators banked outside the building.

It cannot be assumed that a self-cooled transformer will always operate satisfactorily regardless of the conditions of installation. The ideal location for this type is outdoors where free air circulation around the tank will exist at all times. If a self-cooled transformer is installed indoors in a cell without proper openings for air circulation, the service will not be satisfactory, as the transformer will overheat. Under such conditions, sufficient air must be supplied by large intake and outlet openings properly located or the cooling air must be furnished by blowers.

Oil-Immersed Transformers Cooled by Air Jets

By supplementing the convection air currents with small air jets impinging on the radiating surface of radiators, tubes or corrugations, the heat dissipated from the oil will be approximately doubled for the same temperature rise. Also, apparently, the convection currents in the oil are increased, resulting in a faster oil flow and a lower temperature.

The method of applying the air jets has been standardized and consists of an air chamber located directly behind the radiators and attached to the main transformer tank (See Fig. 2). Removable air distribution pipes connected to this chamber release the air in jets upwards along the surface of the radiator at an angle of about 45 deg.

One-half horsepower per 100-kv-a. of increase in transformer output over the self-cooled rating, is all that is necessary to operate the blower, delivering air at 3 oz. pressure. The air-jet-cooled transformer will always have a self-cooled rating approaching 60 to 70 per cent of the air-jet rating. All equipment such as blower, motor and automatic starting equipment, is designed for outdoor service (See Fig. 3). The blades used in

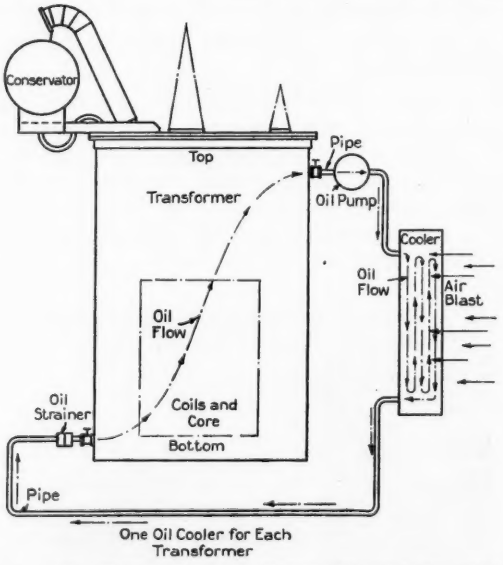


FIG. 6. OIL FLOW IN A FORCED OIL-COOLED TRANSFORMER USING AN EXTERNAL OIL COOLER

the blower are of special design to reduce noise to a minimum. There is no hissing or other noise due to air jets.

If desired, thermostatic control for the blower motor may be furnished to start and stop the blower motor automatically. This control operates on the top oil temperature in the transformer. In most cases, the motor and blower provided for each unit are installed on an extension of the transformer truck.

Water-Cooled Transformers

Wherever water is plentiful and of good quality, water-cooled transformers may be installed. The first cost of a water-cooled transformer is slightly less than that of a self-cooled transformer, since the dissipation of losses by a cooling coil is less expensive than, say, by radiators. This statement is based on the assumption

that both transformers have the same efficiency. There must be considered, however, the additional expense of the water, the piping, and the continuous maintenance.

Such transformers are cooled by water passing through cooling coils of copper immersed in the oil as near the top of the tanks as possible. The hot oil from the core and coil ducts rises to the top of the transformer tank, where the heat passes from this oil through the walls of the cooling coil to the cooling water, which is in continuous circulation through the coil.

In water-cooled transformers, only about 10 per cent of the heat loss is dissipated from the tank wall; therefore, under all conditions of operation, even under excitation only, cooling water must be circulated.

Water-cooled transformers may be built for any frequency, voltage, and capacity. They are suitable for indoor or outdoor installation.

In cases where water is expensive, or where there is a wide variation in loads, a combination self and water-cooled transformer may be used. Such transformers will be placed in tubular, corrugated, or radiator tanks, having sufficient surface to hold the temperature to a safe limit on light load without the use of cooling water. For heavier loads, pipe coils installed in the top oil, in the same location as in a straight water-cooled unit, provide the cooling. When full load is carried, water is circulated through the cooling coil, and the oil is cooled by the combined cooling effect of both the cooling coils and the tank surface. In general, with water cooling, such a transformer will carry 150 per cent of its rated capacity when rated as a self-cooled transformer. Automatic control of water flow, consisting of suitable thermostats and a valve, may be used.

Forced Oil Cooling

Forced oil cooling is popular in Europe and has been in use there for many years. In this country, the demand for such transformers is small.

In this method of cooling, the hot oil in the transformer is drawn from the top of the tank and forced through a separate cooler. The oil, in passing through this device, is cooled by a forced supply of either water or air, generally water.

The oil must be circulated and cooled at all times, regardless of whether or not the transformer is carrying load. Even under excitation, forced circulation of oil and forced cooling are necessary, as the tank surface is entirely inadequate to carry even core loss heat.

The oil pressure must always be greater than the water pressure, to prevent water from entering the oil should a leak develop in a cooler tube. This difference in pressure will always exist when rated oil and water flow are maintained. Oil pressure will not exceed 15 lb. per sq. in., and water pressure will always be less than 2 lb. per sq. in.

Electricity---What It Is and How It Acts*

Part XVII. The Electron's Last Stand. The Story of Its Capture by Millikan in the Ryerson Laboratory in Chicago. By A. W. Kramer

NO SHERLOCK HOLMES ever exercised more cunning nor laid plans for the capture of his victim with greater certainty than did Robert Millikan plan the final capture of the electron. Long had he been on the trail—long had he studied the habits of his victim and gathered the clues furnished by others but the years so spent proved well worth while. With infinite patience, he had worked out a plan of attack which he knew must be successful. Now the trail narrowed and finally, in the quiet and undisturbed fastnesses of the Ryerson Physical Laboratory at the University of Chicago, the elusive electron surrendered to his relentless pursuer.

No surrender was ever more unconditional—it was complete and carried with it no hidden limitations. Townsend's experiments, we have seen,[1] harbored a number of sources of error which rendered the result extremely uncertain. Millikan's method not only eliminated all the uncertainties of Townsend's method but provided an entirely new way of studying ionization.

Millikan's Method Based on Work of Others

The work of Townsend and others who attacked the problem, despite the limitations, was not in vain, however, for Millikan's method was derived from the methods of the previous investigators. In modern science, it is rarely that any single man can be credited with all the honors for an important discovery. In scientific research, evolution works just as surely as it does in other natural processes and methods are evolved from the combined efforts of many individuals.

Townsend had shown how to deal with clouds of water vapor. After Townsend, Thompson and H. A. Wilson of the Cavendish Laboratory produced methods in which the downward fall of such clouds could be counteracted by charged plates above the clouds. In other words, a cloud was placed between the two plates of a condenser. When the upper plate was charged, say, with positive electricity, it attracted the negatively charged droplets in the cloud and so arrested their fall. If the charge on the plate was made high enough, the droplets would actually be drawn upward, against the attraction of gravity. Millikan, himself, worked along these lines for a number of years and it was this work which finally led to the conception of his balanced drop method whereby his final successful results were obtained.

Balanced Drop Method Is Simple

Millikan's method differed from all others in its simplicity and directness. Where others had worked with clouds of droplets, Millikan worked with a single drop.

Suppose that a small single drop of oil, or other substance is placed in the atmosphere between two parallel plates mounted horizontally as shown in Fig. 1. The droplet, obviously, will fall toward the lower plate, due to the attraction of gravity; but, being very small, its

*All rights reserved.

[1]Part XVI, January 15, 1929 issue.

rate of fall will be comparatively slow, due to the viscosity of the air or whatever gas may exist between the plates.

Let us suppose, further, that this droplet carries an electric charge, say a negative charge. Insofar as the action of gravity is concerned, the charge on the droplet will have no effect. It will fall just as fast whether it is charged or whether it is neutral.

If, however, an electric charge is applied to the plates when the charged oil droplet is in the space between, something starts to happen immediately. If the upper plate is given a positive charge (the oil droplet is assumed to carry a negative charge), the droplet will be

FIG. 1. AN OIL DROPLET FALLING IN AIR UNDER THE ACTION OF GRAVITY. ITS RATE OF FALL IS DEPENDENT UPON ITS SIZE AND THE VISCOSITY OF THE AIR THROUGH WHICH IT FALLS

attracted by the plate and its rate of fall due to gravity will be diminished. If the charge on the plate is increased, the fall of the droplet may be arrested entirely or it may be drawn upward. Two unlike charges, it will be recalled,[2] attract each other with a force that varies directly as the product of the charges.

Speed of Droplet Can Be Controlled

The speed of the droplet, therefore, can be varied either by varying the charge on the droplet, varying the charge on the plates, or both. If the charge on the upper plate, for instance, is suddenly increased while the charged oil droplet is under observation, a sudden increase in the upward velocity of the droplet will be observed.

If, while the charge on the oil droplet is still negative, the lower plate is given a positive charge, the rate of fall will be greater than that due to gravity alone.

It is obvious that the rate of fall or rise of the droplet can be definitely controlled by varying the charge on the plate.

Suppose, however, that instead of varying the charge on the plates, the charge on the droplet itself is varied. In this case also, a change in the rate of motion of the droplet will be observed. If the droplet, already carrying a certain negative charge, acquires a greater negative charge by the capture of a negative ion, the rate of upward motion will be increased. The addition of a still greater negative charge by the capture of a second ion will still further increase the droplet's upward velocity.

If, instead of capturing a negative ion (just how these captures are effected will be explained shortly), the droplet captures a positive ion, the rate of motion will decrease and if it captures another, the speed will still further decrease or its motion may be reversed and the drop will move toward the negative plate. Allowing for the effect of gravity, the direction of motion of the droplet, with respect to the charges on the plates, will indicate whether the droplet carries a positive or negative charge.

[2]Part VI, August 1, 1928 issue.

Here, then, we have a method for learning something about the charge on the droplet. If the charge on the plates remains constant and the speed of the droplet is suddenly observed to increase or decrease, we may assume that it has in some way acquired a positive or negative charge as the case may be.

How the Droplets Acquire Charges

A small droplet of this kind may acquire charges in various ways. Usually, if it is formed by atomization by being sprayed from an atomizer, it will acquire a charge by friction. In its rapid passage through the tubes of the atomizer, the scrubbing action may have left it with an excess of negative electrons, giving it a positive charge.

However, the droplet may acquire a charge in another way. It may capture an ion from the atmosphere. In the gases of the atmosphere, there are nearly always some free electrons present. They may be, and are produced naturally, due to radioactive substances in the earth or by the sun or they may be produced artificially by a beam of x-rays or radium rays. Just how they are produced will be described later; here it will be necessary only to assume that these ions are present or that they may be produced.

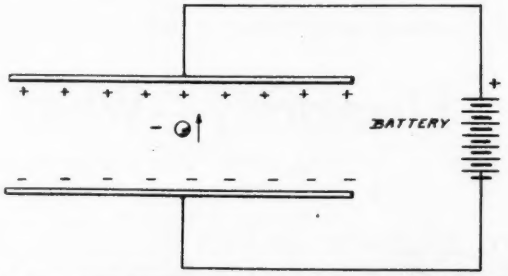


FIG. 2. A NEGATIVELY CHARGED OIL DROPLET BEING DRAWN UPWARD TOWARD THE POSITIVELY CHARGED PLATE, AGAINST THE ATTRACTION OF GRAVITY

In this case, the rate of travel of the droplet depends upon the electric charge on the droplet, and the charge on the plate or rather, the strength of the electric field.

These ions are constantly moving about in the space between the plates and as the oil droplet moves up and down, it is conceivable that occasionally one of these ions will collide with the droplet and be captured by it. The oil droplet, it must be understood, consists of many thousands of atoms most of which are normal; that is, they are satisfied so far as their positive and negative charges are concerned. A small number of the atoms composing this oil droplet, however, may lack an electron or may have an excess of electrons over the required number for satisfaction. It is these unsatisfied atoms which give the oil droplet its charge. If all of its atoms are satisfied, the droplet is said to be neutral and will be unaffected by the charge on the plates. In Fig. 3 is shown a diagram representing an oil drop carrying a single positive charge.

It may not be entirely clear how a droplet carrying, say, a negative charge can acquire a still greater negative charge by the capture of negative ions or electrons. From all we have said, it would seem that an approaching electron would be repelled by the negative charge on the droplet. The explanation lies in the high kinetic

energy of the electrons and ions in the atmosphere. This fact was proved experimentally by Millikan. The ion apparently approaches the oil droplet with such speed as to be able to proceed against the repulsive force of the charge on the droplet.

An oil droplet, therefore, may attach to itself either positive or negative ions. A single electron captured by the droplet shown in Fig. 3 would make the droplet neutral.

In his experiments, Millikan was able to control not only the charge on the plates but also, by means of radium rays, the charge on the droplet. Let us see how he went about this.

Details of Millikan's Experiment

A simple diagram of his apparatus is shown in Fig. 4. The plates between which the oil droplet is floated

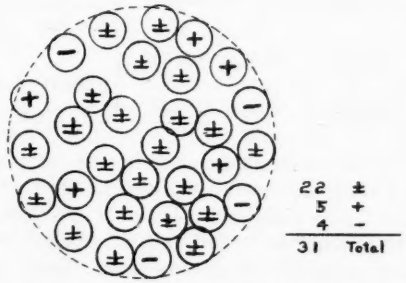


FIG. 3. REPRESENTATION OF AN OIL DROPLET CARRYING A SINGLE POSITIVE ELECTRIC CHARGE

An oil droplet such as Millikan worked with consists of many thousands of neutral atoms, compared to the few that carry a charge. In this diagram is shown a hypothetical oil drop with a total of 31 atoms. Of these, 22 are neutral, 5 carry a positive charge and 4 a negative charge. The net charge, therefore, is positive and in an electric field the drop would tend to move toward the negative plate. If this drop suddenly captured an electron, it would become neutral and it would be attracted only by gravity.

are designated M and N. An aperture, p, in the center of the upper plate connects with a chamber, C, into which an oil spray is blown from an atomizer A. The air with which this spray is produced is first rendered dust free by passing it through a tube containing glass wool. At B is a 10,000-v. storage battery, so arranged that by means of the switch, s, a positive or negative charge can be imparted to either of the plates or by throwing the switch to the left, the plates can be short-circuited, thus discharging them.

When a spray of atomized oil is blown into the chamber, C, the droplets constituting the spray will slowly fall and occasionally one of them will find its way through the aperture, p, into the space between the plates M and N. When this occurs, the aperture, p, is closed by means of a shutter.

To render visible the droplet of oil which has passed through the aperture, it is illuminated by a powerful beam of light which passes through a small window in the ebonite strip encircling the space between the plates. Under these conditions, when the droplet is viewed through a telescope, it appears as a bright star against a black background. Its motion between horizontal hair lines in the telescope can thus be easily observed and its rate measured by means of a stop watch or chronograph.

In performing the experiment, it was found that the droplets which were captured were quite strongly charged by the friction involved in atomizing the oil. As the droplet (which has a radius of about 1/25,000 of an inch) passes through the aperture, p, it is first allowed to fall toward the plate N under the attraction of gravity. Just before it touched the lower plate, the switch was thrown, charging the upper plate with electricity opposite in polarity to that carried by the droplet. In the field thus created, the droplet moves upward and just before it touches the upper plate or when it crosses the upper hairline in the observing telescope, the battery is disconnected and the plates short-circuited, thus removing the field. The droplet again falls and when it nears the bottom plate, the switch is again closed and the process repeated.

Speed of Droplet Varied by Battery

By adjusting the voltage of the battery, the speed of the drop could be regulated to any desired degree. The droplet could be made to move up or down at will or could be held stationary in space like Mohammed's Coffin.

The downward speed of the droplet due to gravity is always the same regardless of the value of the charge.

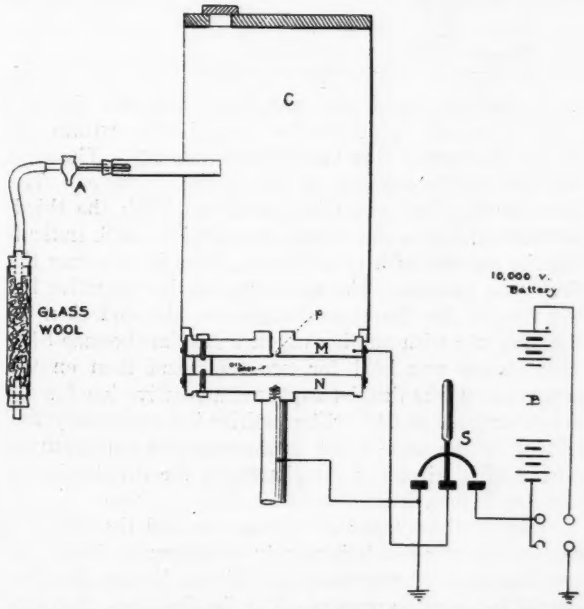


FIG. 4. A SIMPLE DIAGRAM OF MILLIKAN'S APPARATUS

The condenser plates between which the droplet is observed are shown at M and N which are mounted in the lower part of a closed chamber C. An oil spray from atomizer A is introduced into C and as it settles a single droplet will enter the space between the condenser plates M and N through aperture p. A 10,000-v. battery is provided for charging the plates by means of switch S.

With a certain field strength, the rate of upward motion will depend upon the charge on the droplet.

When Millikan first made this experiment, the droplet captured an ion from the atmosphere within a few minutes. This was signaled to the observer by a sudden change in speed when it moved upward with the field on. Now, the experiment consisted entirely in observing and noting the ratio between the various rates of speed as the droplet captured or lost ions.

In the accompanying table[3] are shown the results of one of Millikan's early experiments in which the time

[3]Millikan, The Electron, p. 67.

was determined by means of a stop watch. In this case, the distance between the cross hairs on the telescope corresponded to an actual fall of the droplet of 0.5222 cm.

In Table I, the left-hand column, gives the time (in seconds) of fall due to gravity. In the right-hand column, is given the time required for the droplet to rise from the lower to the upper cross hair.

TABLE I. TIME DATA FROM MILLIKAN'S EXPERIMENT

Time of fall due to gravity	Time of rise in electric field
13.6	12.5
13.8	12.4
13.4	21.8
13.4	34.8
13.6	84.5
13.6	85.5
13.7	34.6
13.5	34.8
13.5	16.0
13.8	34.8
13.7	34.6
13.8	21.9
13.6	
13.5	
13.4	
13.8	
13.4	
Mean 13.595	

It will be noted that the times required for the droplet to fall under gravity are all alike within the limits of error of stop watch measurements. The time require for the droplet to rise varies, however, The time for the first two trip are alike. With the third, however, the time decreased from 12.4 to 21.8, indicating the capture of a negative ion, since in this case the drop was positive. The next trip another negative ion was caught for the time changed to 34.8 and then on the fifth trip with another capture the time became 84.5. This charge was held for two trips and then on the seventh trip, the droplet captured a positive ion for the time decreased to 34.6. The positive ion apparently was of exactly the same value as the negative ion captured on the fifth trip since the charge on the droplet is the same as before.

Having these times of passage, to find the speed in centimeters per sec. it is merely necessary to divide the total distance of movement 0.5222 cm. by the time required to make the passage. For the first trip, therefore the speed will be $0.5222 \div 12.45 = 0.04196$ cm. per sec.

Now in order to make use of this experiment in explaining the properties of the electron, it is necessary only to make one assumption and that is, *that the velocity of the droplet is proportional to the force acting upon it.*[4] The assumption, however, is subject to a delicate experimental test but here we need regard it only as an assumption.

To obtain a comparative measure of the force acting upon the droplet with different velocities, we need only calculate the difference in velocity between the successive changes in speed. From the table, the first two trip it will be noted gave a speed of 0.04196 cm. per sec. (0.5222 ÷ 12.45). The third trip which was made in 21.8 sec. gives a speed of $0.5222 \div 21.8 = 0.02390$. The difference between these successive speeds is $0.04196 - 0.02390 = 0.01806$.

In the same manner, Millikan calculated the differences for each of the speed changes shown in the right-hand column of Table I, as follows:

TABLE II. DIFFERENCES FOR SPEED CHANGES OF TABLE I

Observed Velocities	Difference in Velocities
$0.5222 \div 12.4 = 0.04196$	0.01806
$0.5222 \div 21.8 = 0.02390$	0.00885
$0.5222 \div 34.7 = 0.01505$	0.00891
$0.5222 \div 85.0 = 0.006144$	0.00891
$0.5222 \div 37.7 = 0.01505$	0.01759
$0.5222 \div 16.0 = 0.03264$	0.01759
$0.5222 \div 34.7 = 0.01505$	0.00891
$0.5222 \div 21.8 = 0.02390$	

Even in the preliminary experiments, it was apparent from a study of the values given at the right of the above table that a simple relation existed between these numbers representing the differences in velocities. They are all integral multiples of some unit. Thus,

$$0.01806 = 2 \times 0.00903$$
$$0.00885 = 1 \times 0.00885$$
$$0.00891 = 1 \times 0.00891$$
$$0.00891 = 1 \times 0.00891$$
$$0.01759 = 2 \times 0.00880$$
$$0.01759 = 2 \times 0.00880$$
$$0.00891 = 1 \times 0.00891$$

These values within the limits of stop watch measurement, it will be noted, are all alike. Much more regular results were obtained in later experiments in which a chronograph was used to determine velocities.

Starting with a drop of, say, 100 charges, Millikan varied the charge to, say, 10 and found that every variation was an integral multiple of one unit. Finally, on reducing the charge still further, he found that this unit also was two or three times the same unit, thus showing that the charge originally given to the drop by friction as it passed through the atomizer was also built up of "atoms of electricity."

These relationships, throughout the years that they have been observed by Millikan and others, have been

[4] If e is the value of the charge on the droplet; m, its mass; v_1, its velocity under gravity g, alone; v_2 its velocity in an electric field x, we have the relation

$$\frac{v_1}{v_2} = \frac{mg}{xe - mg}$$

from which

$$e = \frac{mg}{xv_1}(v_1 + v_2) \quad \ldots\ldots 1$$

If, now, by capture of an ion, the drop changes its charge from e to e' we may denote the new velocity corresponding to this charge as v_3. Then, from equation I, the value of the captured charge e" is

$$e'' = e' - e = \frac{mg}{xv_1}(v_3 - v_2)$$

Since $\frac{mg}{xv_1}$ is a constant for the drop, any charge which it captures will always be proportional to $v_3 - v_2$. In other words, it will be proportional to the change produced in the velocity by the captured ion.

found to hold absolutely without exception, no matter in what gas the droplets have been suspended nor of what material they were composed. Millikan has held a given drop under observation for five or six hours at a time and during this time the droplet has been observed to capture not six or ten ions but hundreds of them. In Millikan's own words,[5] "Indeed, I have observed, all told, the capture of many thousands of ions in this way and in no case have I ever found one, the charge of which, when tested as described, did not have exactly the value of the smallest charge ever captured or else a very small multiple of that value. Here, then, is direct, unimpeachable proof that the electron is not a 'statistical mean' but that rather the electrical charges found on ions all have either exactly the same value or else a very small multiple of that value."

As explained in earlier articles of this series, long before Millikan's work, physicists had been confident that electricity was atomic but in Millikan's experiment they were furnished with absolute and incontrovertible proof.

And by such beautifully simple means. Who would have thought it possible to devise a method so simple and direct that it could have been used a century ago, which proved the atomic nature of electricity to within 1 part in 1000? This gives us the answer to the question which we asked in Part XV, "What, after all, have we to prove that the electron really exists?" Beyond all question, electricity, by Millikan's experiment, is shown to be made of tiny specks which are all alike. Here we have outlined the method without regard to refinements. Later, Millikan performed the experiments with greater accuracy and while his results were more accurate, his original conclusions remained unchanged. In the next article we will discuss the numerical value of the charge.

[5]Millikan, The Electron, p. 70.

Stoker Advantages and Disadvantages*

ALTHOUGH THERE ARE a great number of successful stoker installations, it is well known that there are many that are not all that the purchasers expected, and some that are outright failures. It is a fallacy to believe that one type of stoker can be used for all types of installations and fuels. In many instances of stoker applications in existing plants, the type of stoker best adapted to fuel, ratings, or conditions cannot be installed owing to physical conditions of plant layout.

It is as difficult to divorce the stoker proper from the furnace as it is to separate definitely the boiler efficiency from the furnace efficiency. Therefore, when we consider troubles in stoker installations, we must not only consider the stoker itself but the furnace, the adaptability of the equipment and even the auxiliary apparatus required by the installation.

Stokers can, in general, be divided into six classes, all distinctly different and adapted to different uses. They are:

1. Hand or semi-automatic.
2. Overfeed, inclined, or V-type.
3. Natural-draft chain or traveling grate.
4. Industrial underfeed, single, double, or lateral retort.
5. Forced-draft chain or traveling grate.
6. Multiple-retort underfeed.

These six types divide themselves roughly into two classes of installations: A, the lightly loaded, short-hour, or low-load factor industrial plant; B, the heavy-duty, continuously operating, central-station or industrial plant. Stokers of Types 1 and 2 belong naturally in plant A class, while stokers of Types 5 and 6 are adapted to plants in class B exclusively. Stokers of Types 3 and 4 may be used in either class of plant, depending upon their size and how definitely the work to be done approaches that of class A or B.

Water Walls and Preheated Air Now Popular

Furnace design is dependent upon the work required. Owing to the inherent mixing of air and fuel by all stokers, the furnace volumes required are less than with any other type of fuel-burning apparatus. Underfeed stokers require less volume than other types and multiple retorts require the least per delivered heat units. On the other hand, slagging of boiler tubes, fly-ash and cinders are greatest with multiple-retort underfeeds and least with natural-draft overfeed stokers. This is owing to the higher rates of combustion and greater air velocities.

Use of water-cooled furnaces is increasing and is purely a financial engineering problem. Their application to stoker front walls has shown clever designs and good service. Preheated air has been used successfully with stokers, with moderate temperatures on existing installations and with high temperatures on those stokers designed especially for its use.

Power required for operating stokers is low, even with multiple-retort types. Power for forced draft rarely exceeds 7 or 8 kw. per ton of coal and decreases with lowered ratings. A safe figure to use for underfeed stokers for fan and stoker drive is 4 kw. per ton at normal rating, and 12 kw. at 300 per cent of rating. Forced-draft traveling grates require about 25 per cent less power for operation.

Many stoker installation failures are owing more to too small a stoker for the coal, rating and plant conditions, than to the make, or even type, of stoker selected. The forced-draft traveling grate is the only stoker suitable for anthracite and coke breeze. Its advantage for bituminous coal occurs where the fusing point of the ash and its clinker is such that excessively large stokers of the underfeed types must be used, resulting in poor flexibility and high cost of the latter.

Multiple-retort underfeed stokers, when properly installed, are capable of efficiently burning practically all types of bituminous coals. When all factors are considered, they are cheaper to install under large boilers for high outputs and efficiencies than other types of high-duty stokers.

*From a paper presented at the Second National Fuels Meeting of the A. S. M. E., by Theodore Maynz.

Inland Power & Light Co., Portland, Oregon, is making plans for a hydroelectric development on the Lewis River in Washington where it is proposed to construct four power dams to have gross output of 230,000 hp.

Make the Climate Fit Your Process

By controlling temperature and humidity with air conditioning equipment, thus improving products and processes otherwise affected by weather variations

MODERN INDUSTRY is indebted to the science of air conditioning for much of the success it has enjoyed in quantity production of materials whose characteristics are affected by the weather during manufacture. In many industrial processes, the temperature and relative humidity exert such effects on the material involved that it has often been necessary to stop production during certain periods.

In this article we are not concerned primarily with the effects of properly conditioned air on the comfort and health of the workers but rather with its effects and uses in the processes themselves. By properly conditioned air is usually meant air which is not only at the proper temperature but also at the proper humidity, since it is the combination of the two factors that in most cases produces the proper result when adjusted to the given conditions.

In certain types of industries, especially those classified as metal working, effect of moisture in the air on the manufactured product is extremely small. In such industries, it is usually necessary only to heat the buildings so that they will be comfortable to work in. Steam radiators and unit heaters are ordinarily used for this purpose. The unit heater is designed to blow or draw air over heater coils and direct it to the breathing zone, thus producing proper distribution and circulation of air.

Typical Applications of Air Conditioning in Industry

In other industrial processes such as textile manufacturing, baking, candy-making, airplane building and so on, effect of the relative humidity of the air upon the product may be such that control of temperature alone will not be sufficient without accompanying control of moisture.

For example, textile fibers are extremely sensitive to moisture in the air and since most of the processes in textile manufacturing are mechanical, the final result depends largely on the condition of the fibers during

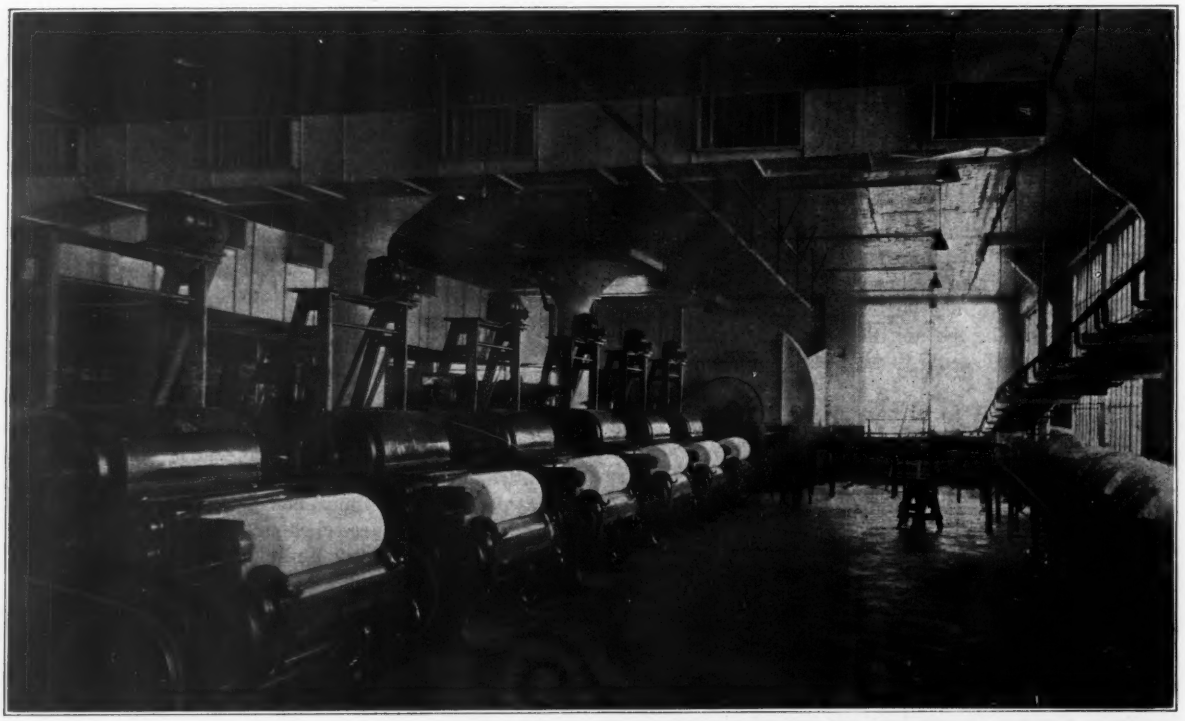


FIG. 1. PICKER ROOM OF COTTON MILL WHERE PROPER HUMIDITY AND TEMPERATURE ARE MAINTAINED

the processes. By proper control of moisture and temperature under which these fibers are worked, their pliability can be regulated, fly or waste minimized, broken ends can be reduced, maximum and uniform strength and weight can be obtained and static electricity can be eliminated. The accompanying table shows the room temperatures and humidities recommended for best results in various textile processes as well as in other industries.

Engineers familiar with the textile mill of 20 or 25 yr. ago will remember that the picker room seldom appeared like the one shown in Fig. 1. This shows a modern picker room supplied with air at proper temperature and humidity, producing correct conditions for the cotton and comfortable, sanitary working conditions for the operatives.

Humidity and Tobacco

Tobacco is extremely sensitive to weather, both in the curing and manufacturing processes. By use of properly conditioned air, seedlings can be grown under glass and kept ready for transplanting at the proper time. Curing has also been carried on with conditioned air by several companies. In all the processes of making cigars and cigarettes, proper humidity has been found to reduce breakage and waste, assist blending and improve the operation of the machinery. Figure 2 shows a modern cigar factory where conditioned air is used for these purposes.

In candy-making, proper humidity and temperature have been found to permit close control of the quality, color and texture of both chocolates and hard candy and thus obviate necessity for changing formulas or processes to meet weather variations. Figure 3 shows a cocoa grinding room supplied with conditioned air.

Enumeration of other industries in which the product has been controlled by properly conditioned air would include the industries making cereals, bakery goods, macaroni and paste goods and so on. The table shows the conditions recommended for baking processes.

Moisture and the Printer

One of the most difficult problems faced by the printer, especially in fine color printing, is the effect of hot, damp weather on registration. Changes in humidity cause paper stock to shrink and make registration often impossible, affecting also the inking of type and plates. By use of air at proper humidity, these difficulties have been overcome in many printing establishments.

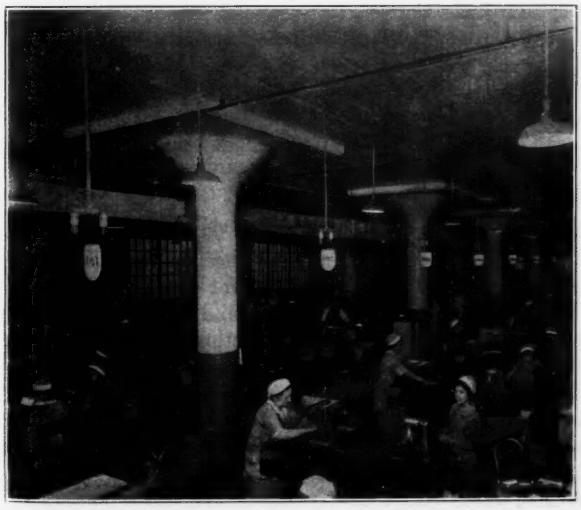


FIG. 2. CONDITIONED AIR IMPROVES OPERATION OF CIGAR-MAKING MACHINERY

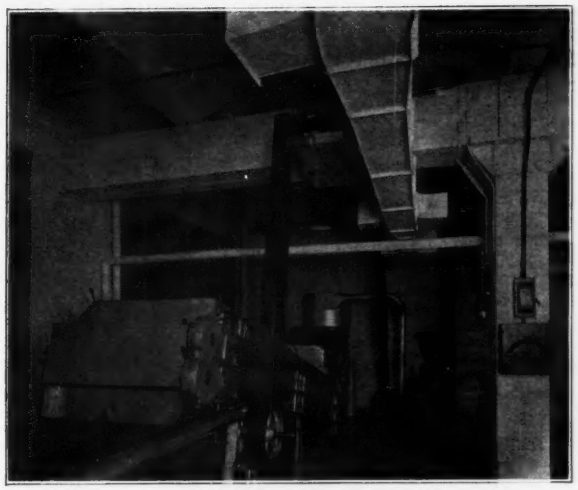


FIG. 3 COCOA GRINDING ROOM IS SUPPLIED WITH CONDITIONED AIR

In the manufacture of airplanes, where wood, fabric and other materials sensitive to moisture must be worked, control of humidity and temperature by air conditioning apparatus has been carried out to speed up production and permit proper construction.

Drying of finishes, such as paints, enamels and lacquers and drying of other materials has often been

TABLE SHOWING FAVORABLE CONDITIONS OF TEMPERATURE AND HUMIDITY ARTIFICIALLY MAINTAINED IN CERTAIN MANUFACTURING PROCESSES

Industry and product	Process	Temp., deg. F.	Relative humidity per cent
Cotton	Carding	68 - 73.4	50
	Combing	68 - 73.4	60 - 65
	Roving	68 - 73.4	50 - 60
	Spinning	68 - 73.4	60 - 65
	Spooling, twisting	68 - 73.4	65
	Warping	68 - 73.4	65
	Weaving	68 - 73.4	75 - 80
Wool	Carding	73.4 - 77	65 - 70
	Spinning	73.4 - 77	55 - 60
	Weaving	68 - 73.4	50 - 55
	Storage for shipping	68 - 73.4	55 - 60
Silk	Dressing	69.8 - 77	60 - 65
	Spinning	69.8 - 77	65 - 70
	Throwing	69.8 - 77	65 - 70
	Weaving	69.8 - 77	60 - 70
Confectionery	Chocolate enrobing	64.4	> 55
	Hard candy making	69.8	> 50
	Storage	30.2	> 70
		59*	> 55
Tobacco	Softening	84.2	85
	Cigar and cigarette making	69.9-73.4	55 - 70
Printing	Lithographing	69.9	45
	Relief and offset	77.0	45
	Folding	77.0	65
	Binding	69.9	45
Baking	Dough fermentation	80.6	65
	Proofing	89.6 - 95	80 - 90
	Loaf cooling	69.9	65
Electrical Cable	Winding insulation	> 104	> 5
Cellulose lacquers	Application	75.2	> 20
Munitions	Fuse loading	69.9	55
Cereals	Seal packing prepared crisp cereals	73.4	45 - 50

*Divergence in practice

improved by control of humidity. These processes really involve hardening, rather than drying, and it has been found that this hardening often takes place better with moist air than with dry air.

Making Motion Picture Film

In the making of motion picture film, dust must be eliminated during the processes and properly humidified air has been found effective in doing this. Also, static electricity has given considerable trouble in this process and this has been effectively prevented by control of moisture in the air.

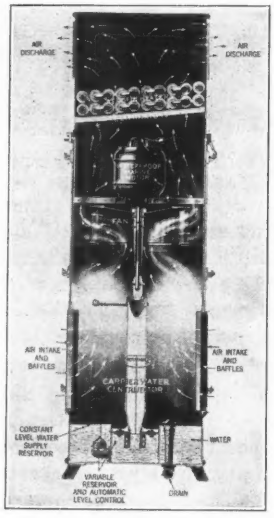


FIG. 4. UNIT AIR CONDITIONER

Above are only a few of the many ways in which industrial processes have been improved by control of moisture and temperature together.

Air Conditioning Equipment

To effect this control, air conditioning equipment often consists of a central installation for bringing the air to the proper conditions and it is then distributed by ducts to the rooms or processes where it is needed. Figure 5 shows a typical installation of air conditioning equipment. Fresh air and recirculated air enter as shown, pass through a fine cloud of atomized water (produced by nozzles or sometimes by rotating plates) which washes and purifies it. The air then passes through eliminators to remove excess water but to leave in the water vapor. During the summer, the water can be cooled by refrigeration and this cool water in turn cools the air and causes the excess moisture carried by the outside atmosphere to be condensed. In winter, the water adds the proper amount of humidity. By regulating the temperature of the water, almost any desired condition can be produced. By use of evaporative cooling, air can be cooled simply by passing through the water spray, since the absorption of moisture by the air causes the heat in the air to be given up to the water.

Various forms of humidifiers and dehumidifiers are used, sometimes with heating or cooling coils for the air and sometimes by controlling the temperature of the spray water. Figure 4 shows a form of unit air conditioner recently developed for applications in which the central or duct system might prove too cumbersome or expensive.

Water sprays in a humidifier or dehumidifier serve to wash dust from the air. Various forms of air filters are also used for this purpose but these are beyond the scope of this article.

Automatic Control

One of the principal features of present-day air conditioning equipment is the fact that it can be controlled entirely by automatic methods to maintain the desired conditions. Various types of thermostats and regulating valves govern the temperatures and amounts of air and

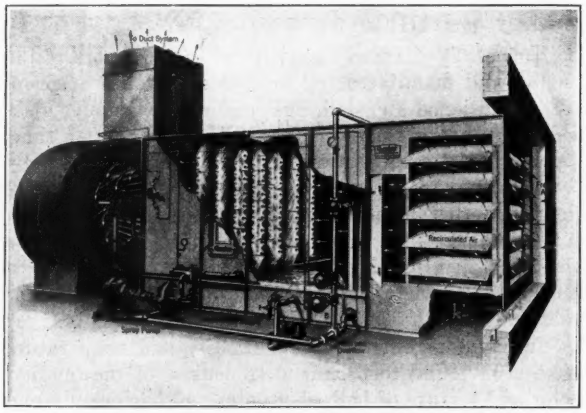


FIG. 5. SPRAY CHAMBER, FAN AND AUTOMATICALLY CONTROLLED AIR DAMPERS OF A TYPICAL AIR CONDITIONING SYSTEM

moisture and once the proper setting is determined and proper care given the equipment, the climate in the industrial process is kept within the prescribed limits automatically.

First Pass Soot Blowers

In connection with the question of difference of opinion as to the desirability of soot blowers in the first pass of boilers, our attention has been called to the fact that in the list of stations presented and analyzed in the December 15 issue, all except the Edgar Station and the Hudson Avenue Station of the central station plants have blowers in the first pass. This would seem to indicate that practice favors the use of such blowers, whatever may be the opinions expressed in discussion of the matter.

According to a recent announcement by the H. K. Ferguson Co., Cleveland, Ohio, for the first 8 mo. of 1928 there was no fatal accident and no permanent disability incurred in the construction and engineering work of the company. The company's score is slightly over 99 per cent, based on the standard A. G. C. system of scoring. Figures have also been set up for individual superintendents of the company and show that during these eight months one man had five consecutive perfect scores, three had four perfect scores, three had three, four had two and six had one each, a total of 40.

Moderator System Varies Heating Steam Supply

BALANCES SUPPLY OF STEAM AUTOMATICALLY TO COMPENSATE FOR VARIATIONS IN OUTDOOR TEMPERATURE, SHUTTING OFF OF RADIATORS AND OTHER FACTORS

FOR VARYING supply of steam delivered by a heating system to the building as a whole and to each radiator in particular, balancing the supply of steam with every change in outside temperature or normal inside demand, the new Webster Moderator system has been developed.

This system is designed to give full automatic variation of steam supply, to provide for changes in demand resulting from variation of outdoor temperature or from shutting off or turning on of radiation, to compensate for variation of steam pressure above the minimum, resulting from uneven firing and to compensate, in vacuum systems, for variation in degree of vacuum in returns, within limits established for the system.

It is also designed to give convenient manual variation of steam supply to provide for changes in demand resulting from changes in weather conditions other than temperature and to provide for quick heating up and night load conditions.

Amount of steam delivered to all or any part of a heating system is dependent on the difference in pressure between the point from which the flow starts and the point at which the flow terminates, together with the resistance to flow existing between the two points. The Moderator system is designed to control steam flow by predetermining and maintaining as closely as practicable these differences in pressure throughout the system.

KEEPING THE RIGHT PRESSURE DIFFERENCE AT B

How this is accomplished is shown in Fig. 1. An air-circulating system produces continuously and automatically just ahead of point B an air pressure equal to the pressure difference which should exist between the supply and return mains of the heating system. The air compressor 1 in the basement maintains a constant pressure on a small air line leading to the roof thermostat 2. The amount of air flowing past the valve of the roof thermostat 2 and into the line A-B is varied by changes in outdoor temperature. This air is continuously discharged to the atmosphere at B through a restricted opening, with the result that a certain pressure is maintained just ahead of B. When the temperature decreases, the amount of air flowing into line A-B increases and the pressure ahead of B is correspondingly increased. When the temperature increases, the amount of air flowing into A-B decreases and the pressure ahead of B is correspondingly decreased.

VARIATOR GIVES HAND CONTROL OF PRESSURE AT B

The area of the restricted opening at B may be changed by the operating engineer by moving the variator lever C. Reducing the opening increases the pressure ahead of B; increasing it decreases this pressure. The pressure ahead of B is therefore always under the influence of both the roof thermostat and the variator; the operation of one does not nullify the effect of the other but the air pressure produced ahead of B is always the result of operation of both units. This air pressure is applied to a mercury balance D, which mechanically actuates an oil pilot valve E in the oil circuit.

Oil pressure is maintained by a pump built into the air compressor unit 1. Movement of the oil pilot valve E in one directions sends additional oil to the operating piston of the main steam control valve 4, opening this valve and increasing the steam supply until the difference in pressure between supply and return is maintained equal to the air pressure ahead of B. Movement

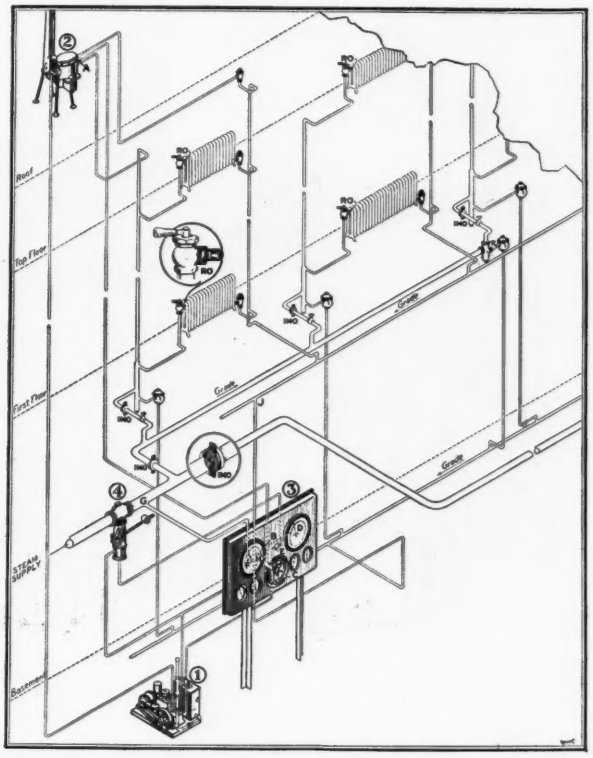


FIG. 1. DIAGRAMMATIC ARRANGEMENT OF ELEMENTS IN MODERATOR SYSTEM

of the oil pilot valve in the opposite direction produces an opposite effect by permitting oil to flow from the operating piston of the main steam control valve back to the oil reservoir at 1.

ORIFICES AID IN CONTROLLING STEAM FLOW

In the Webster Moderator system, the resistance to flow is made up of two elements: a small element due to the friction of pipe and fittings and a large element due to the installation, in series, of restrictions called metering orifices, located at selected points throughout the system. The total resistance of these metering orifices is proportionately great and the resistance due to pipe friction small so that the metering orifices largely determine steam flow.

The size of the opening in each metering orifice is individually calculated from the radiation or heat loss and piping data for the building, as supplied by the

consulting engineer or designer of the systems. The calculation of these sizes is done by the orifice calculation department of the home office of the manufacturer. Each metering orifice is then made to the required dimensions at the factory. Intermediate metering orifices, IMO, Fig. 1, are located in the branch mains and riser laterals at the steam supply. Each intermediate metering orifice sets up sufficient resistance so that the steam flowing past is proportionate to the requirements of the section served. Metering orifices (marked RO in the illustration) are also installed in the supply valves

Changes in demand may result from weather conditions other than temperature; for example, a strong wind may result in increased demand for steam on the windward side of the building. Such a demand is met by the variator. Movement of the variator lever C from normal to 120 per cent restricts the opening at B, increasing the pressure ahead of it and supplying the entire system with 20 per cent more steam than would be normally required for the outside temperature and inside demand conditions prevailing. Thus sufficient steam is supplied to the cold side of the building to

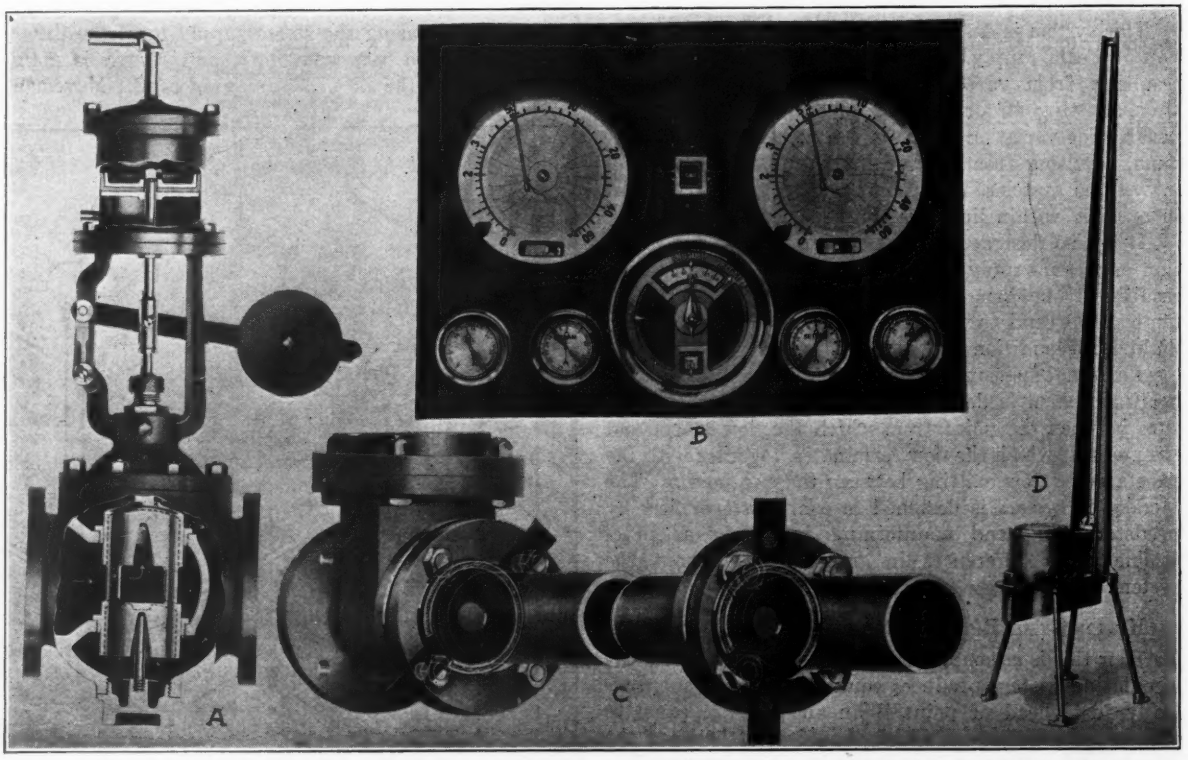


FIG. 2. IMPORTANT ELEMENTS IN THE SYSTEM. A—MAIN CONTROL VALVE, ADJUSTED BY OIL PILOT VALVE. B—MAIN CONTROL BOARD SHOWING MERCURY BALANCES, VARIATOR AND GAGES. C—TWO TYPES OF INTERMEDIATE METERING ORIFICES. D—ROOF THERMOSTAT ACTUATES SYSTEM TO VARY STEAM SUPPLY WITH VARIATION IN OUTDOOR TEMPERATURE

of each radiating unit, sized to pass the proportionate amount of steam required for the unit.

But changes in demand for steam may result from shutting off or turning on radiation. Or an increase in supply, not needed, may result from increased pressure ahead of the main steam control valve or from an increase of vacuum in the returns (of vacuum systems). These conditions tend, of course, to change the difference in pressure between supply and return which must be kept the same as the air pressure ahead of B.

These changes are met automatically as follows: A duplicate mercury balance F in the control panel is connected to steam supply and return mains through pipes G-F and E-J. Departure of the difference in pressure between these two points from that called for by the air pressure ahead of B results in movement of this second mercury balance which is also connected to the oil pilot valve E, accomplishing an adjustment of the main steam control valve so that the steam pressure difference is again equal to the air pressure ahead of B. This adjustment is made continuously and automatically.

maintain comfortable warmth. The warm side will be slightly overheated unless the radiator valves are shut off (or adjusted, if graduated valves are used). This overheating occurs, however, during only a small portion of the heating season and the waste is but a small fraction of that occurring in conventional heating system under similar conditions.

Warren, Webster & Co., its manufacturer, has pointed out that it is not prepared to accept orders on a production scale because of the made-to-order characteristics of the system, which will be understood from the foregoing description.

As at present developed, the system is adaptable to the heating of buildings requiring 10,000 sq. ft. or more of radiation but equipment suitable to the requirements of smaller buildings will be available later on.

It is stated that the new system is not what is commonly known as a temperature control system. Where this is desired, thermostatic control of each radiator may be used in combination.

Oil Grooves Present Problem in Rebabbiting

WEAR OF A BEARING on a large shaft was such that it became necessary to rebabbit it. No difficulty was anticipated in pouring the top half of the bearing, but the bottom half was more complicated because it had, in the cast iron shell, a groove for the oil chain, and a large lengthwise groove for an oil cellar that had to be left open. The construction of the bottom half of the shell was as shown in Fig. 1. The cavities in the casting

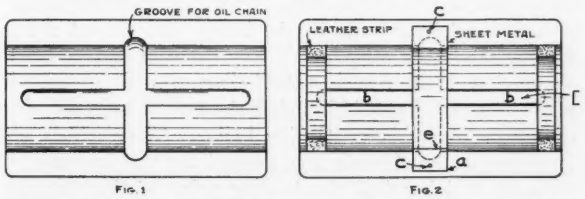


FIG. 1. CONSTRUCTION OF BOTTOM HALF OF SHELL SHOWING OIL GROOVES AND CAVITY FOR OIL CHAINS
FIG. 2. METHOD OF PLACING PROTECTING STRIPS

will be noted and the main problem resolved itself into pouring the babbit around these cavities without allowing the metal to run into them.

Several ways were considered, some of them being to drive blocks of wood into the grooves, filling the grooves with sand or with stiff clay but each way considered had some objection and it was finally decided to cover the grooves with sheet metal as shown in Fig. 2. The piece a, was cut about ½ in. wider than the oil chain groove, bent to the radius of the casting and pinned down with copper rivets driven in holes drilled for them and headed over as shown at c, c.

The pieces b, b were also cut slightly wider than the lengthwise groove, each edge crimped down at right angles and driven into the grooves, joining up closely to the piece a on each side.

All joints were then rubbed over with stiff clay and leather strips of the proper thickness for the babbit laid in each end of the shell, over the strips b, b. The shaft was then lowered into place, mudded around the ends of the bearing shell and the babbit poured in from both sides. After raising the shaft again the strip a was cut off and both ends lifted out at e, e, which left openings for the chain to enter and leave the oil well, yet the babbit was cast solid from end to end.

Coffeyville, Kansas. EARL PAGETT.

All Steam Should Be Charged to Departments

PAUL F. ROGERS' DISCUSSION of the above subject in the issue of Nov. 15 is practical and frank. It undoubtedly requires the tact of a statesman to charge steam or any fluid to the various departments without starting a lot of howls and arguments, in which he is often the goat. In my own case, however, I have never had any disagreements with the accounting department, which usually took the word of the steam engineer who made the distribution. I may have been exceptionally fortunate.

To meter the steam to the various departments is not so easy, even if you have a plentiful supply of meters. One must, then, rely upon some standard operations and tests on the various units in the departments and empirically evolve formulas to be applied to each department, based upon conditions of operation. This, of course, is a "scientific guess" and my guess was usually better than anyone's else.

Contrary to Mr. Rogers, I favor basing the steam distribution on the boiler house output, rather than on the total steam distributed to the departments. This not only renders the steam distributor's job more difficult in accounting for all the steam produced but it gives the boiler house a cost of its own. To base the cost of steam per unit of generation, say 1000 lb. of steam, on the accounted for distributed steam, may show a high steam production cost that would certainly react against the boiler plant operation. The boiler plant is just as concerned about its costs as any department. The department heads don't miss any chances of throwing costs on the boiler department, which as Mr. Rogers correctly states, is non-productive, gets no credit for records or production peaks, but in case of failures in plan operations, takes a lot of blame that does not belong to it.

If the cost per 1000 lb. of steam based upon net output from the boiler plant is say 40 cents, and it figures $1 as in Mr. Rogers' example, based upon accounted for steam, the chances are that the boiler superintendent reaches the carpet for the latter figure. I would therefore recommend this method of distributing steam where a large amount of steam is unaccounted for:

1. Determine the net cost of steam per 1000 lb. based upon actual output of boiler plant. 2. Distribute steam to departments as usual, totalling all steam accounted

for. 3. Reduce the department steam distribution figures to a percentage basis. 4. Apply this percentage to the total boiler plant costs for the final department steam costs.

In this way, the unaccounted for steam can be neglected and the actual boiler house cost of steam production is protected. The departments are not interested in the cost of producing steam, but the management is. The boiler house, however, is interested in the quantity of steam used by the departments, and it is entitled to credit for the total steam produced, regardless of where used. It goes without saying that large unaccounted for steam losses invite thorough investigation, and a revamping of the methods of steam distributions.

Dayton, Ohio. C. W. STEVENS.

Examinations for Operating Engineers

WHILE THE EDITOR brought out an important point in the editorial regarding engineer's examinations, it is evident that the data he used were sent in by an engineer who failed. Any suggestions regarding changes in examinations would probably be considered more favorably by the examiners if they came from successful applicants as it is likely to be said that the others have an ax to grind. The examination in Massachusetts is oral and I have found that, when a man fails to pass, he usually failed on several questions and seldom can he remember clearly just what those questions were. One thing that puts a man in a bad light with the examiner is the habit of being only half correct in his answers.

One man was asked, "How is reduction in load taken care of on a Corliss releasing gear engine without racing the engine?" His reply was "Oh a cam does the whole business," and in spite of much patience on the examiner's part, he could not be induced to say whether it was the safety cam or the knockoff cam and he blandly overlooked the fact that the governor position changes and the cam collar is moved by reach rods at each change in load.

"How would you secure an earlier cutoff on a Corliss condensing engine when the steam pressure cannot be raised?" Many men have said they would shorten the reach rods and have been refused a license for the reason that, if the valves are once set correctly, this adjustment will derange the setting of the safety cam and, in case of a governor belt breaking, the steam valves may hook on full stroke instead of being tripped by the safety cam. Life and property are by no means safe with this type of engineer in charge. It is a common thing to hear these men declare all questions impractical that they cannot answer.

These men get hold of an old list of examination questions and learn them by heart, then are indignant when the examiner springs a few that are not listed. There exists no good reason for sticking to the same questions that were asked 15 yr. ago for, although a man could safely operate a slow-speed engine at 100 lb. pressure it does not follow that he can operate turbines of fifty times the capacity at 1,200 lb. What is required in a plant is not a memory expert but a man who has so thoroughly mastered the fundamentals of power plant theory and practice that he can reason out the answer to a question he has never heard before without reading it off his cuff.

Too often it is considered by employers that a good mechanic is necessarily a good engineer but the contrary has often been proved. A man in this city failed to pass for a second class license and, instead of studying further, stated that he did not want the license anyhow, bragging that he was the equal of most engineers holding a first class license. One day his engine developed a pound and he pulled the main bearing up tight which did not eliminate the pound, but did wipe the babbit across the oil grooves. After listening to the pound, I went into the boiler room and noted the steam pressure to be 110 lb. Knowing that the safety valves were set to blow at 135 lb., I added another weight to the damper regulator which opened the damper and caused the pressure to rise in a few minutes to 125 lb. At the increased pressure, the pound disappeared. It was in the governor as will always be the case with this type of engine at overload or low steam pressure.

Knowledge of the characteristics of power equipment is fully as important as manual skill. Another engineer installed a new boiler to operate at 160 lb. pressure and stated that he had done all erecting work with only common labor for helpers, thereby apparently saving money for his firm. This boiler replaced heating boilers that had operated at 15 lb. pressure and he was advised by several engineers to use different feedwater from that used in the old boilers. In a few months he had a deposit of hard scale in the boiler and was at a loss for the reason or remedy. Heavy doses of soda ash did no good and, after seeing the boiler, which had bagged above the fire, I concluded that the use of soda ash was disastrous for this particular boiler. The sudden appearance of hard scale was caused by the increase in pressure which raised the boiling point of the water in the boiler from 250 to 370 deg., naturally causing more solids to precipitate. Further deposit of solids on the shell and tubes was due to the fact that the boiler operated at 175 per cent of rating whereas the old units, with double the heating surface, evaporated only half as much water per sq. ft. Had he increased the amount of blowdown, the evil might have been lessened but the same old schedule was followed as for years. The addition of soda ash aggravated the trouble as it would not dissolve completely but settled in a large lump over the fire sheet and hastened the bagging of the plate.

I was operating a plant on the same river and found it impossible to use soda ash as much refuse containing acid was dumped into the river upstream, so that even if the soda was dissolved in pure water in a tank before being fed, part of it would pass over with the steam and the rest would merely build up on the scale, forming another layer, most of which went to the fire sheet. Of course the small plant engineer cannot be a fullfledged chemist but he should be posted on some of the common feedwater troubles.

Incidentally, I have found that the men who want the examinations modified are the same men who complain that the engineering game is no good, the salaries too low and too many engineers on the market. If we adopt their suggestions and make the requirements easier, will there not be even more engineers in the market and how can conditions ever be improved by lowering the standard of intelligence and ability? A

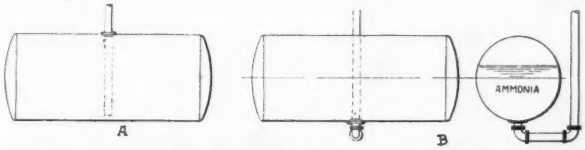
boiler insurance company recently issued a pamphlet emphatically advocating the employment of the highest grade men available for operation of high-pressure boilers and they have the greatest possible interest in safety. According to predictions on engineering development, we will have in the future boilers operating at a thousand per cent of rating carrying 1500 lb. pressure, steam superheated to a point where the piping and high pressure end of turbines will be heated to a cherry red when in operation. A nationally known consulting engineer states that a major difficulty will be to find capable men to supervise operation.

Springfield, Mass. A. F. SHEEHAN.

That Mysterious "Dip Pipe"

NOT LONG AGO, I asked a manufacturer of refrigerating equipment why he connected his ammonia receiver as shown in Fig. A. I pointed out to him that the construction shown in Fig. B is much simpler, better, and less expensive.

He replied that a dip pipe, as shown in Fig. A, "looks more mysterious" and he doesn't want his system of refrigeration to look too simple. With the construction shown in Fig. A, the user is liable to



SIMPLER PIPING ARRANGEMENT ON AMMONIA CONDENSER RESULTS IN IMPROVED CONSTRUCTION

wonder how the liquid ammonia can flow upward out of the top of the tank. The explanation, of course, is simple. It is because of the ammonia pressure inside of the receiver which forces the ammonia into the lower extremity of the dip pipe and then upward.

A serious disadvantage of this mysterious method is that as soon as the level of the ammonia falls beneath the end of the dip pipe, no more ammonia can pass out except in the form of a gas, in which case the vessel itself, Fig. A, becomes very cold. In other words, refrigeration occurs before the ammonia reaches the expansion coils.

Figure B is preferable because it will remove all of the ammonia, is less expensive and is more easily understood. It seldom if ever pays to shroud mechanical processes in mystery. The simpler a given machine or process can be made, the better.

Newark, N. J. W. F. SCHAPHORST.

Elbows Cause Vibration in Steam Pipes

SUCH VIBRATION DEVELOPED in a long and crooked 8-in. steam pipe which supplied steam to a long stroke engine that the engineer became alarmed and watched the pipe and its junction with the fittings closely and promptly shut down the engine when a small crack and attendant leakage developed at a fitting, thus probably preventing a bad case of steam pipe breakage.

There were four elbows in the steam pipe, two vertical and two horizontal. One of the vertical elbows was about 10 ft. above the boiler and the other vertical elbow was about 18 ft. above the engine. The two horizontal elbows were located not far from the vertical down-pipe to the engine and most of the vibration seemed to be at the horizontal elbow nearest to the engine. An attempt was made to anchor the steam pipe at the point where it passed through the boiler house wall, a few feet distant from the first vertical elbow, which as stated, was above the steam boiler. Thinking that this elbow would take care of the pipe expansion between the boiler and the brick wall, heavy clamps were bolted to the steam pipe at the wall, and also bolted to the wall. The steam pipe vibration, however, tore the fastenings loose and demolished a portion of the wall immediately around the steam pipe. Notwithstanding, the vibration at the engine and of the pipe did not seem to be lessened materially and when leakage developed in the vertical elbow directly above the engine, the plant was promptly shut down.

Finally, the engineer developed an idea that the pipe vibration was caused by sudden lowering and increasing of pressure inside the pipe as the long stroke engine took steam. He further reasoned that the pipe vibration would be lessened, if not prevented, by erecting a sort of steam chamber in the pipe, which should absorb, or at least cushion, the pressure fluctuations. Accordingly, he broke out the pipe line above, removed the horizontal elbow nearest to the engine and replaced it with a tee, one end of which received the pipe leading toward the engine, while the unused end of the tee pointed directly away from the pipe from boiler. The longest length of 8-in. pipe obtainable was screwed into the open end of the tee, and this pipe formed a continuation of the pipe leading from the boiler. The far end of the length of pipe was capped and the new length of pipe, similar to the rest of the 8-in. pipe line, was hung from the ceiling above. The extra length of pipe was found to act in a manner similar to an air chamber on a water pipe. In other words, it was a "surge reservoir" and its usefulness was evidently limited by its capacity, which was not great enough to completely absorb the pipe vibrations. Still, it did lessen them to a considerable extent.

It was evident that the capacity of the steam-cushion pipe was not great enough to absorb all the pressure fluctuation impulses in the pipe line, but it did prove sufficiently effective to prevent further breaking of any of the pipe fittings and also to prevent further tearing down of the boiler house wall. Some time afterwards, during a shutdown for repairs, the engineer took down the entire pipe line, abandoned the horizontal elbows as well as the makeshift steam chamber, and ran the steam pipe direct from boiler to engine, with the exception of the two vertical elbows which were retained. The pipe was anchored to the boiler-house wall in its new location and proved almost entirely free from vibration, thereby showing that the numerous elbows had much to do with causing the excessive vibration.

Indianapolis, Ind. JAMES F. HOBART.

INDEPENDENCE, Iowa, hydroelectric plant, which was recently sold by the Northeastern Iowa Power Co. to the Central States Light Corp., has been connected by the new owners to its other northern power lines and has become an integral part of that power system.

Questions and Answers

Volute and Involute Pumps

IN SPEAKING of centrifugal pumps, I would like to know the difference between volute and involute pumps.

J. K.

A. Volute pumps are low-pressure centrifugal pumps usually built without discharge or diffusion vanes. Instead of such vanes, the casing is of a spiral type, the cross-section so proportioned as to produce an equal velocity of flow at all sections around the circumference and also gradually to reduce the velocity of water as it flows from the impeller to the discharge pipe.

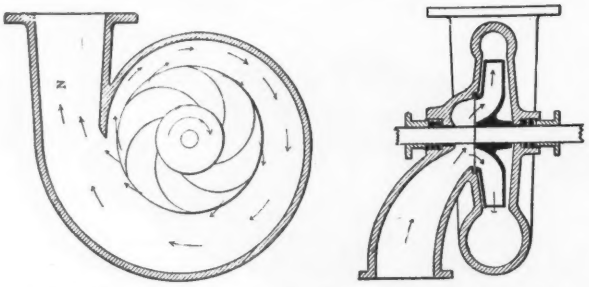


FIG. 1. VOLUTE PUMP HAS SPIRAL CASING IN ORDER TO PRODUCE EQUAL VELOCITY OF FLOW AT ALL SECTIONS AROUND CIRCUMFERENCE

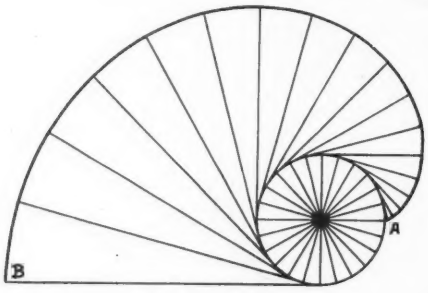


FIG. 2. INVOLUTE CURVE IS DEVELOPED BY UNWRAPPING STRING FROM AROUND A CYLINDER

Water enters the rapidly revolving vanes on the shaft, usually in an axial direction at the center of the wheel. It is discharged from the vanes by centrifugal force at the periphery of the wheel or impeller, into the volute casing, which conducts the water to the discharge pipe. The tapered portion N, Fig. 1, between the casing proper and the discharge pipe is often called the nozzle. The spiral curve is often called a volute, whence the pump has received its name.

Involute is hardly a proper term to indicate a type of pump. It has reference only to the form of the curve given to the tips of the impeller vanes of some centrifugal pumps but the common forms are circular arcs with involute tips. Involute is a name given to that curve which is formed by the end of a string when it is unwound from a cylinder while being kept taut; consequently, the string, as it is unwound, will always lie in a direction of a tangent to the cylinder, as shown in Fig. 2, in which the curve A-B is an involute curve.

Pump Operation Cost and Duty

WILL YOU KINDLY find the estimated cost for running an 8 and 5 by 10-in. duplex pump for one hour, operating at 24 strokes per minute with a steam gage pressure of 100 lb. and working against a head pressure of 185 lb.?

How much water will be pumped per hour?

G. M.

A. The number of feet traversed by the piston per minute will be $24 \times 20 \div 12 = 40$ ft.

The capacity of a 5-in. dia. cylinder is 1.02 gal. per ft. per min., therefore, two cylinders will pump $40 \times 1.02 \times 2 = 81.6$ g.p.m., which is the capacity of the pump.

$$81.6 \times 60 = 4896 \text{ g.p.hr.}$$

The weight of water pumped per minute will be $81.6 \times 8.33 = 680$ lb.

The head in feet will be $185 \times 2.31 = 428$ and the foot pounds of work done per hour will be $680 \times 428 \times 60 = 17{,}460{,}000$ ft. lb.

The duty of a pump of this type and size is 19.6 million ft. lb. per thousand pounds of steam. Therefore, the estimated steam consumption under full load conditions will be $17.46 \div 19.6 \times 1000 = 890$ lb. of steam per hour.

For a pump of this type and size the normal speed would be about 45 to 50 strokes per minute, therefore, the pump in question is operating at about one-half speed, in which case the duty will be only about 90 per cent of that at full load.

Therefore, the estimated steam consumption for the conditions in question would be $890 \div 0.90 = 990$ lb. per hr. and the cost of the steam used, estimated at a fair rate of 60 cents a thousand pounds, will be 0.990×60 or 59.4 cents per hour.

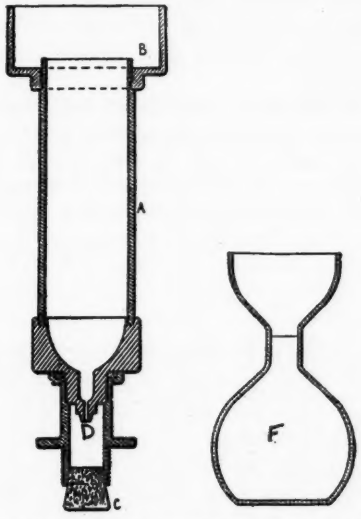
Saybolt Test Determines Viscosity of Oil

WHAT IS THE MEANING of the word Saybolt in connection with tests of lubricants? J. H.

A. The Saybolt test for lubricants is one used to determine the viscosity, that is the tendency the lubricant has to retain an unbroken film between the parts to be lubricated. Viscosity is measured by observing the time required for a certain volume of the liquid to flow, under stated conditions as to head, through a

short tube of small bore. The Saybolt Universal viscosimeter has a vertical tube 0.483 ± 0.004 in. long and 0.0695 ± 0.0006 in. dia. For heavy oils the Saybolt-Furol viscosimeter is used; it differs from the Saybolt in having a tube diameter of 0.1240 ± 0.0008 in. The time of efflux of 60 c.c. in seconds is the viscosity in seconds Saybolt. The time of the efflux of the Furol is approximately 1/10 that of the Universal. Viscosities of lubricants are measured at 100 deg. and 212 deg. F.

Apparatus for making the Saybolt test shown in the illustration consists of a metal tube A, 1.17 in. dia. and 3½ in. long with an overflow cup B, an outlet tube D



SAYBOLT VISCOSIMETER DETERMINES ABILITY AN OIL HAS TO MAINTAIN AN UNBROKEN FILM BETWEEN THE PARTS LUBRICATED

about ½ in. dia. and a constant-temperature bath (not shown) surrounding A, with special thermometers designed for total immersion, graduated to 0.2 deg. F., for measuring the oil and bath temperatures. The receiving flask F has a capacity of 60 c.c. at 68 deg. F. The tube is cleaned, then flushed with warm oil of the sample to be tested and the cork stopper C inserted, forming an air cushion between the stopper and outlet tube. The sample is heated to nearly the test temperature and poured into the tube until it overflows. When it ceases to overflow into the overflow cup it should be slowly raised to the desired temperature by heat applied outside of the bath, which can be filled with water for tests at 77 deg. or 122 deg. F. Both liquids are stirred and, when the temperatures become constant, a pipette is used to lower the oil level in the overflow cup below the top of the tube. The receiving flask F is so placed that the current running into it will strike inside of the neck so as to avoid foaming and a stop watch is used to note the time intervening between the removal of the cork and contact of the bottom of the meniscus with a mark on the flask.

VIRGINIA-CAROLINA POWER CO., operated by the Virginia Electric & Power Co., Richmond, Va., has plans under way for a hydroelectric plant on the Roanoke River near Roanoke Rapids, N. C. According to present plans, the plant will be equipped for an output of 20,000 hp.

Rigid vs. Flexible Couplings

REFERRING TO the question on this subject published on page 1206 of the November 15 issue, I believe the flexible couplings used to join the turbine shaft must have been somewhat like the Thomas coupling used by some makers in the United States between turbine and generator. These couplings are used mainly to take care of the expansion caused by change of temperature and also for limiting the vibration set up, to the unit which causes it so that this is not transferred to the other unit, as would be the case if a single or solid coupled shaft were used.

It is likely that, due to the turbine being built up of units and exhausting into several condensers, the four condensers did not work exactly the same at all times and the difference in temperature may have varied enough to cause a local change of the shaft's length and possibly to set up a stress to the cylinder frame. In such a case, a flexible coupling would be the proper type to use. Each cylinder is balanced for thrust but, if later on it is out of balance, the unit at fault would show it more plainly singly than if it were connected with other units through a solid shaft.

As I understand it, the makers used the flexible couplings to take care of the expansion as the main object in their special construction.

Death Valley, Calif. CHAS. LABBE.

Unbalanced Pressure Operates Safety Valve

HOW MANY POUNDS pressure would be required to operate a safety valve which is set in series with another similar safety valve, both being set to pop at 100 lb.? The second safety valve receives the steam discharged from the first one. A. C. S.

A. Let us first consider the pressure conditions when only one safety valve is used. In this case, if it is set at 100 lb., it should pop at that pressure and discharge at atmospheric pressure.

If, now, we connect in series two such safety valves each of which is set to pop at 100 lb., it is plain that the pressure on each in excess of the discharge pressure must be 100 lb. but while the discharge pressure of the second safety valve is atmospheric, that of the first one of the series must be 100 lb. in order to operate the second safety valve, therefore the pressure needed to operate the first safety valve in the series connection must be 200 lb.

This is a theoretical value but it is approximately correct. Practically there would be some losses that would alter this figure slightly.

Pressure Rises if Safety Valve is Too Small

WHAT CAUSES the pressure on a boiler to continue to rise after the safety valve has popped? The one attached to our boiler originally popped at 100 lb. pressure but later was set to pop at 85 lb. It starts to pop at that pressure but the pressure on the gage continues to rise to 95 lb. W. F. S.

A. If the steam continues to rise after the safety valve has popped, it is an indication that the valve is not large enough for the service demanded. Steam is being produced faster than it can pass through the valve.

Editorial Comment

Accumulators for Handling Central Station Peaks

Once more the important question of base-load and peak load operation has been stressed by Professor Christie in his paper presented before the December A. S. M. E. meeting, which discusses the adaptation of the steam accumulator to peak load conditions in central stations. Recently there has been considerable advocacy in some cases of low-cost, rugged, peak-load plants. In the past few years, several stations designed primarily as base-load plants have seldom operated entirely on that basis. This has been caused by the rapid changes in the operating conditions of the large transmission systems with which they have been connected. Besides, conditions are not always the same regarding the value of peak load plants.

Professor Christie suggests the use of the steam accumulator with a peak-load turbine for handling peak loads, analyzing its advantages for various conditions and load factors.

Improved boiler operation and savings in fixed charges are the two principal advantages he cites, under the conditions he has assumed. If the base of the peak exceeds 4 hr., the accumulator loses its advantage, he states, in favor of the peak-load plant. It is also important to note that his analysis shows the largest savings for accumulators and peak-load units when added to a system consisting of standard plants with modern equipment only.

Many engineers, we find, are surprised at this suggestion that the accumulator may find application in the central station. They have seen it installed in industrial plants and its more extensive use for such plants has been advocated. According to Professor Christie's analysis, however, the accumulator can lead to interesting savings in the handling of central station peak loads and has already done so abroad. While he has assumed certain operating conditions which may be difficult to duplicate, he has indicated a method of solving the problem that should prove interesting, if applied to an actual case. In view of the vital importance of higher load factor, it is our feeling that his paper merits careful consideration by the central station engineer.

Power Consumption An Index of Business Activity

Although electric power production as a whole continues to increase at a satisfactory and healthy rate, certain sections of the country show losses, in spite of the general prosperity of the country.

During October, practically every section of the country showed an increase in kilowatts output over the corresponding month in 1927. The single exception was the east south central part, which reported a loss of 7 per cent. This loss was confined entirely to the state of Alabama. The neighboring state of Mississippi showed a gain of 38 per cent.

Another apparent inconsistency occurred in New England, New Hampshire falling off 15 per cent, while Vermont gained 138 per cent during the year. In the South-Atlantic section, Delaware fell off 43 per cent while Maryland gained 118 per cent. Minnesota, Arkansas, Utah and Nevada also showed losses of from 8 to 21 per cent.

Power consumption is beginning to be considered an important index of industrial activity or prosperity because of the intimate part it plays in all industries. Purchased power, as reported by the Geological Survey, does not take into consideration power generated within industrial plants; nevertheless it is now used sufficiently in all industries to serve as an indication of the industry as a whole.

Doubling Our Prime Mover Economy

With the development of customer ownership markets, popular financing and the necessity for maintaining good public relations, the public utility companies are forced to describe the construction and operation of their power houses in non-technical language sufficiently simple to meet the demands of the public for information.

Usually, this is handled by the publicity department which often employs considerable ingenuity. One such report describing a recent central station compares the condenser to "a large hogshead over 40 ft. long with an exaggerated bung at the top through which the exhausted steam enters."

Having exhausted the steam in the first sentence sufficiently to render it helpless, the report continues on to the execution, "inside the hogshead are innumerable small brass tubes having a total length of 179 in. Each tube is filled with cold running water. When the hot steam strikes these tubes it is cooled to the point where it is condensed into water, which is why the machine is called a condenser."

All of which, no doubt, proves interesting to the prospective bondholder, although perhaps leaving him somewhat at a loss to know why power plant operators should be the favored few to have large "hogsheads."

The remarkable performance and utility of the condenser is usually overlooked, or overshadowed by more spectacular equipment. The condenser is as old as the steam engine; in fact, the early engines used the engine cylinder merely as a condenser, all the external work of the engine being done by atmospheric pressure and the steam serving simply to lift the piston to the top of the cylinder.

It was not until double-acting engines with separate condensers were developed that the full possibilities of the condenser were utilized and it was not until the

development of the turbine that it was found advisable to work down to the lowest temperature limits allowed by the average water supply.

From an efficiency standpoint, the condenser is the most important piece of equipment in the plant. Its loss would mean practically cutting the thermal efficiency of the plant in half. With a small expenditure of power, the condenser in the average plant doubles the part of heat in the steam available for work, reclaiming it from what would otherwise be lost in the exhaust.

As a piece of power plant equipment, the condenser can be classified as non-productive. The publicity man who was quoted before rightly compares the condenser with "an ice-water pitcher on a warm summer day," producing nothing, yet a great help and comfort to those in the vicinity.

Modern Fuel Burning Equipment

With properly designed equipment and a well planned installation, practically any fuel can be burned successfully. It is unreasonable to expect to burn all grades of fuel in one furnace, of course but, with the fuel known beforehand, there is little excuse for failure of a new plant to come up to expectations.

Unfortunately, the designing engineer is sometimes overly enthusiastic for, when working with other people's money it is easy to forget that after all, the average small industrial plant is more interested in cheap and dependable power than in fuel economy.

Knowing full well that he and the operating engineer enjoy about the same complementary relation as the physician and undertaker, the designer is free to exercise his imagination and experiment to his heart's desire; to take credit for any improvements and pass the buck to the operating engineer in case of failure. Regardless of misapplications, it is practically impossible to build a new plant, which will not show a considerable fuel saving over the replaced one, often 15 or 20 years old. This saving is usually the only basis of comparison used.

New equipment and the development of new ideas are important if our industry is to advance but it is questionable how far an engineer is justified in trying unproved equipment in small plants where possible savings cannot possibly offset the risk of a breakdown.

What Is Excellence Worth to You?

When you have to buy a new boiler or a new generating unit or a new boiler feed pump, how do you decide which one of the many manufacturers' proposals to accept?

It must be recognized, said L. B. Bonnett several months ago in an A. S. M. E. paper, that selection of material to be purchased must be a matter of judgment and cannot be a matter for rigorous mathematical solution. Judgment can usually be reënforced, however, by information regarding all factors in the problem; when it is so reënforced, it has a much better chance of being correct. Relative importance of the factors influencing preference must also be considered.

How can best results be obtained, especially in a large company in which purchasing and engineering functions are separated, as is often the case? Mr. Bonnett tells how this is done in a large public utility company and it would seem that the procedure deserves to be known more generally throughout the field.

Briefly, the scheme is to encourage the freest and most open competition among the manufacturers of equipment by making them feel that excellence of performance has a definite and recognized value. To bring about this feeling, the specifications for equipment are prepared in such a way that they describe the operating results to be obtained and the methods by which the various proposals will be compared on both engineering and economic bases, rather than specifying exactly what form the equipment is to take. In short, the object is to allow each manufacturer to propose the best equipment he can build to fit the operating requirements, rather than to force him to build a particular design of equipment and then try to make it give the required results.

After these proposals are evaluated from the engineering viewpoint and the fixed charges and operating costs compared, the prices (which have been submitted separately) are considered and all the factors evaluated together to make a choice.

It is not possible here to give complete details of the method but the utility company that uses it has generously made all the information available and any engineer who is genuinely interested can secure it. It seems to point the way to an extremely effective method of securing the best equipment that can be built for a given service, at the same time allowing the manufacturer to build it as well as he knows how and to do so on a sound financial basis. Advantages of these methods, both to the purchaser and to the manufacturer, should be obvious.

Copper Production and the Electrical Industry

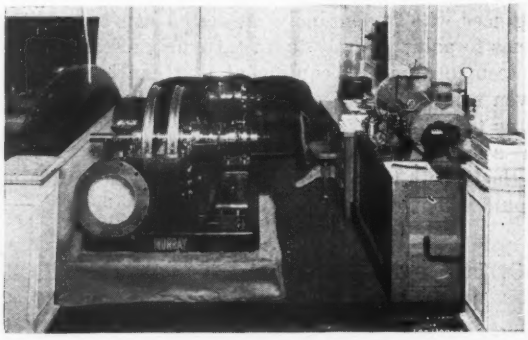
Indications of the extensive growth of the electrical industry as a consumer are seen in reports of the copper industry. Practically 50 per cent of the total United States copper consumption of about one billion tons per year is now used in the various branches of the electrical industry, approximately three-quarters of this being used by the electrical manufacturers and for transmission lines, the remaining 25 per cent being used for telephone and telegraph systems.

Most notable changes in the proportionate consumption of copper are, of course, found in the electrical power and light industry, this consumption having increased fourfold since 1920. When it is realized that the power industry in a short span of years is well on the way to absorbing the output of one of our oldest industries, the importance of power in our modern industrial organization is apparent.

Before the American Gas Association, H. C. Porter said: "It seems that further progress in the field of hydrogenation is likely to hinge on practical working demonstrations on a suitable scale of the use-value of the coke or semi-coke, made by these processes. Boiler furnace, gas generator and domestic heating trials will need to be carried out thoroughly and by impartial agencies before the use of this system of coal processing can be widely extended."

Power Interest *will center in* Chicago

HERE IN the greatest among producing centers of the country for power will be held a conference of engineers for the discussion of power generation and use and an exhibit of equipment which manufacturers provide to assist in these operations. Recent figures show that in the middle west there are produced 225,000,000 tons of coal annually, that the installed primary horsepower in the utility plants on the four states bordering Lake Michigan is over 8,000,000, that there are over 15,000 power plants and over 40,000



manufacturing plants, with proportionate equipment and interest in power use.

Power Conference Sessions

Beginning on Tuesday noon, February 12, the Power Conference will hold sessions through until Friday morning. Registration for the Conference will begin at 9:00 o'clock Tuesday morning in the fourth floor lobby of the Palmer House and the first session will be a noon luncheon in the Red Lacquer Room with an address by President W. L. Abbott. In the afternoon at 2:00 o'clock, a session will be held devoted to Foundation Construction with L. R. Howson as chairman. Papers to be presented will be by H. G. Roby of the Byllesby Engineering & Management Corp., Chicago, on the Details of Design and Construction of the Stream Flow Power Plant at Louisville, Kentucky. By J. C. Sanderson, of Sargent and Lundy, Chicago, on Power Plant Substructure Problems. By P. E. Stevens of the Byllesby Engineering & Management Corp., Chicago, on the Design and Construction of Substructures in Steam Power Stations in Various Localities in the United States.

Chemical and Electrical Problems

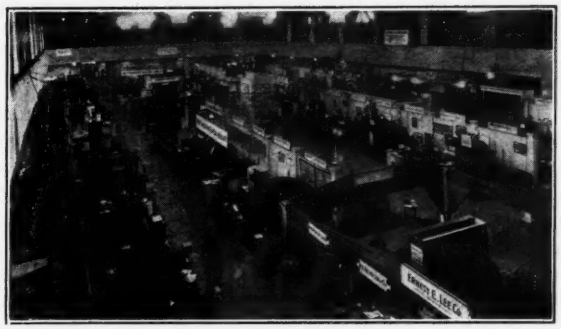
Wednesday morning the session will convene at 10:00 o'clock and will be devoted to Metallurgical and Chemical Problems in Connection with the Power Plant, the chairman being C. C. Whittier. Papers to be presented will be by Professor A. E. White of the University of Michigan on Metallurgy of Material Used in Power Equipment. By J. H. Logan, electrical engineer of the Bureau of Standards, Washington, D. C., on Researches in Corrosion. By Dr. C. M. A. Stine of the DuPont Co., Wilmington, Delaware, on Utilization of Power in Chemical Industry.

At noon a luncheon meeting will be held under the auspices of the American Institute of Electrical Engineers, Chicago section, with R. F. Schuchardt, president of the American Institute of Electrical Engineers, presiding. G. L. Clark, professor of chemistry of the University of Illinois will deliver an interesting illustrated address on Sightseeing Among the Atoms and Molecules.

In the afternoon a meeting at 2:00 o'clock will be devoted to electrical engineering problems with P. B. Juhnke as chairman. Papers will be presented by C. E. Stewart of the General Electric Co. of Philadelphia on Synchronous Supervisory System and Telemetering. By W. F. Sims, engineer of the Commonwealth Edison Co. on The Trend of Development in Electricity Supply Systems.

Heating, Refrigeration and Plant Operation

On Thursday morning a session will be held at 10:00 o'clock devoted to Heating, Ventilating and Refrigeration Problems with Professor A. C. Willard, of the University of Illinois, as chairman. Papers will be presented by S. C. Bloom, consulting engineer, Chicago, on Refrigeration and Ventilation as Aids to National Efficiency. By A. J. Authenreith of the Middle West Utilities Co., on Application of Refrigeration to Preservation of Foods, Taking into Consideration Cold Storage, Packing Houses and Transit. By Samuel R. Lewis



of Chicago on Research as Applied to Heating and Ventilating.

At the noon luncheon meeting which will be under the auspices of the Western Society of Engineers, John A. Garcia, president of the Western Society, will be chairman, and the speaker will be R. C. Allen of the Westinghouse Electric and Manufacturing Co., Philadelphia, Pa.

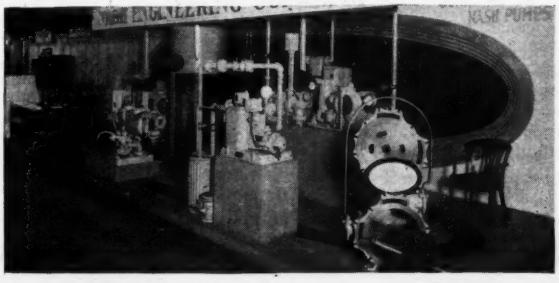
Power Plant Operation will be the subject of the afternoon session at 2:00 o'clock with Julius L. Hecht, vice president of the Public Service Co. of Northern Illinois, presiding. Papers will be presented by Professor A. F. Scherzer of the University of Michigan on Centrifugal Pump Economics. By R. J. Gaudy of Sessions Engineering Co., Chicago, on The Coördination of Industrial Plant and Central Station Power. By Fred G. Outcalt of the Linde Air Products Co., on The Welding of Power Plant Piping.

In the evening a banquet and dance will be held in the Grand Ballroom of the Palmer House on the fourth floor at 7:00 o'clock with a speaker of national prominence not yet announced.

Power Plant Economics

The final session will be held on Friday morning at 10:00 o'clock and devoted to Power Plant Economics, Dean A. A. Potter of Purdue University acting as chairman. Papers to be presented will be Twelve Hundred Pounds Pressure as a Dollar Saver by Edwin Jowett of Kansas City Electric Co. Plant Practice and Engineering Insurance by J. P. Morrison of the Hartford Steam Boiler Inspection and Insurance Co. Modern Stoker Equipment by Professor C. F. Hirshfeld, Chief of Research of Detroit Edison Co.

As an indication of the interest and effort which are behind the arrangements for the Midwest Power Conference, these are in the hands of a committee representing local sections, regional and professional divisions of the national societies of civil engineers, mining engineers, electrical engineers, mechanical engineers, refrigerating engineers, heating and ventilating engineers, National Electric Light Association, National Safety Council and the Western Society of Engineers.



All meetings will be held in the Red Lacquer Room of the Palmer House at Monroe and State Streets, where ample facilities for speakers and audience have been provided. Visitors are requested to register for conference meetings at the headquarters on the fourth floor, which can be reached by special elevator. To cover the expense of the meetings, which includes postage, clerical work and meeting facilities, a registration fee of $1 is asked. All members of the affiliated societies mentioned above are eligible to attend and members are requested to show society affiliation or membership card when registering.

Reduced Railroad Rate

A railroad rate of one and one-half fare on the certificate plan will be in effect, the securing of this fare depending upon the presentation of not less than 250 certificates held by members of the affiliated societies and their families. This fare is authorized from the entire United States and many Canadian points. Certificates should be obtained from ticket agents at the

time of purchasing the tickets to Chicago and should be deposited with the secretary of the Conference at the Palmer House. Such certificates can be secured from February 8 to 14 except that in Arizona, British Columbia, Idaho, Montana, Nevada and Oregon, Utah and Washington, they can be secured from February 6 to 12; in Colorado, New Mexico, Wyoming, Feb. 7 to 13; California, Feb. 5 to 11 and from Oregon via California Feb. 4 to 10. A special railroad agent will be at the Conference Feb. 12 to 15 for validating certificates, if 250 or more are presented, and such certificates will be honored until Feb. 19 for purchase of return tickets at half fare from Chicago to the original starting point, over the same route as used on the trip to Chicago. It should be understood that, in order to make the return half-fare available, 250 certificates must be presented and it is urged that members of the affiliated societies coming to the Conference be sure to get certificates and turn them in, even if they are not in position to use them, so that other members of the Conference may have the benefit of the return half-fare.

For the banquet on Thursday evening, the charge for a cover is $5.00 and as a large attendance is assured, it is desirable for all wishing to attend to send reservations in advance to Robert H. Bacon, chairman of the banquet committee, 900 S. Wabash Ave., Chicago, enclosing check in the proper amount for the number of tickets desired and making the check payable to K. A. Auty, treasurer.

Exhibits of the Midwestern Engineering and Power Exposition will be arranged in the Coliseum, Wabash Ave. near 16th Street, and will cover the entire ground floor. It will be zoned according to classification of exhibits for the convenience of visitors to save the time of those interested in special classes of equipment. Arrangement of the booths is as shown in the accompanying illustrations, the section to the left being known as north hall, the center section as the main hall and the right hand section as the south hall.

In the north hall two zones have been established, that above the ten-foot aisle in the plan, which will be at the rear of the hall, being known as zone E and devoted to refrigeration. The section in front of the ten-foot aisle will be known as zone F and will include heating, ventilation and insulation equipment. In the main hall, zone A, which will be from the center of the main hall to the left and in front of the ten-foot aisle, will include water and steam specialties, pumps, condensers, and lubricants. The booths in this part of the main hall to the rear of the ten-foot aisle will be included in zone D and will be devoted to fuel, oil and gas burning, and refractories.

Zone B, which is to the right of the main entrance in the main hall and in front of the ten-foot aisle, will be devoted to meters, instruments, valves, bearings, traps and operating equipment while zone C at the rear of the ten-foot aisle, will include boilers, air, gas and steam equipment and piping. In the south hall, section H at the rear, will include industrial handling, scales and hoists, while section G to the front of the hall will include building equipment and transmission apparatus.

It will be noted that in the numbering of booths, the numbers start in the main hall at the left hand front corner and run back and forth lengthwise of the hall, the numbers being from 1 to 234 inclusive. Booths in the north hall are numbered 400 to 462, the numbers running back and forth from back to front. In the south hall the numbers are from 300 to 342 running back and forth from back to front.

Diversity Will Be Found

In a general way, the Exposition will have wider diversification and a greater number of exhibits than in the past and will cover the important fields of generation, utilization and distribution of power. An unusually large number of exhibits of heating, ventilating and refrigerating equipment will be displayed. Many of the exhibits throughout the entire Coliseum will be shown in operation to demonstrate the advantages which the apparatus offers.

It is to be noted that the Exposition in Chicago will be held in alternate years from now on so that the next show will be held in 1931. It is, therefore, of special importance to those wishing to investigate and examine the latest equipment in the field to take advantage of the Exposition this year.

To save time and derive the greatest benefit from attendance, it will be, of course, necessary to plan the trip so that the visitor will be sure to see all those things in which he is particularly interested and the following directory of exhibits will permit of doing this. Preparation of a notebook as outlined in our November 15, 1928 issue is of importance, not only in order to save time and avoid overlooking any desired exhibits, also that one may carry away the greatest possible amount of valuable information from the Exposition and have data in hand for future reference when needed.

POWER PLANT ENGINEERING will be found in booth 54 and we invite all our friends and readers to make this their headquarters for appointments and for the securing of any information which they may desire, either in regard to the Power Conference, the Exposition or visits which they may wish to make about the city.

Directory of Exhibits

Aerofin Corporation Booths 407, 408
750 Frelinghuysen Ave., Newark, N. J.

Apparatus for heating or cooling air will be displayed and the action fully demonstrated.

Representatives: Herman D. Jackes, sales manager; George W. Barr; William L. Peplinger; Robert M. Stikeleather; John F. Hole.

Air Preheater Corp. Booth 99
25 Broadway, New York, N. Y.

Here will be found a display of the Ljungstrom air preheaters showing application to modern boiler plants by scene-in-action photographs and also by large photographs of installations.

Representatives: H. Butt; E. A. Kerbey; G. O. French.

Alexander Brothers Booth 167
14 South St., Philadelphia, Pa.

Tentacular transmission belting, operating on short center drives, will be shown and demonstrated in this exhibit, illustrating the belting as running under normal operating conditions and showing the construction of the belt with narrow longitudinal strips fastened by hollow brass rivets on the back of oak-tanned or Balata belting.

Representatives: J. L. de Rabot, consulting engineer in charge.

The Allen-Sherman-Hoff Co. Booths,71, 72
225 S. 15th St., Philadelphia, Pa.

Pumping of ashes by the Hydrojet system will be illustrated by a scene-in-action picture and a full-size model will be exhibited of the steel vertical pump used with this system. Full explanation and demonstration will be given of the action of the system and its advantages.

Representatives: E. W. Titus; James Stokoe.

American Arch Co., Inc. Booth 102
17 E. 42nd St., New York, N. Y.

Type A unit with supported side wall construction and air-cooled bonded refractory wall construction will be shown here, also the American Suspended Arch.

Representatives: G. S. Carrick, general manager industrial department; F. D. Hazen, Pittsburgh manager.

American Blower Corp. Booths 68, 69
6000 Russell St., Detroit, Mich.

This space will be devoted to the Home ventilator for providing better conditions of ventilation and humidifying in dwellings.

Representative: K. J. Murphy.

American Pulverizer Co. Booth 135
1249 Macklind Ave., St. Louis, Mo.

Here will be exhibited a working model of the improved S series American ring crusher with enlarged photographs illustrating various types of ring crushers and installations of importance. Special features will be the eccentric adjustable grinding plate, external tramp metal pocket and Timken roller bearings, incorporated in the S type of ring crushers.

Representatives: Ernest E. Lee; John L. Higgins; C. M. Hardin.

American Schaefer & Budenberg Corp. Booth 22
338 Murray St., Brooklyn, N. Y.

Full display will be made of the products of the Consolidated Ashcroft-Hancock Co., Inc. This will include American temperature controllers for regulation of temperature, pressure, liquid level, air flow and the like. Also there will be shown cast iron and cast steel pop safety valves for working pressures up to 1500 lb., relief valves, control valves for 1500 lb. pressure, pressure and vacuum gages, forged steel, globe, angle, gate and check valves and cast steel blowoff valves.

Representatives: W. P. Bradbury, sales manager; Charles Stepan, western manager industrial sales; A. G. Marshall; M. S. Palmer; W. Loos.

Ames Pump Co., Inc. Booths 39, 40
90 West St., New York, N. Y.

Products shown here will be a full line

of vacuum pumps for heating systems, for condensates and other uses, showing interior and exterior construction.

Representatives: Charles F. Ames; C. Yeomans; R. H. Frederick; A. H. E. Berchem.

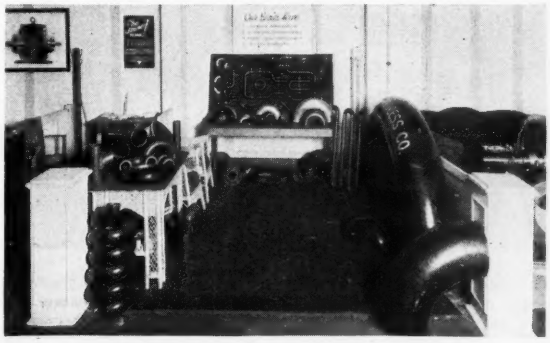
Appleton Electric Co. Booth 173
1701 Wellington Ave., Chicago, Ill.

Equipment for electric conduit installation, including threaded and no-thread Unilets, also a new line of malleable Unilets, will be displayed. A particular feature will be the Reelites which are an automatic system of take-up reels for electric cables.

Representatives: A. S. Merrill, general sales manager; E. A. Hakanson; A. F. Hakanson; J. T. McHenry.

Armstrong Machine Works Booth 404
Three Rivers, Mich.

This company will exhibit its complete line of Armstrong steam traps, including standard cast-iron types, forged steel traps for high pressures, compound traps for handling large quantities of water at high pressures as from separators and



purifiers. Of special interest will be a glass model of the Armstrong trap operating on steam pressure to show the entire cycle of operation of the inverted submerged bucket trap. The body of the trap as well as the bucket will be of glass. The demonstration will show how air-binding is eliminated without wasting steam, quick action of the valve which prevents wire drawing and self-scrubbing action to eliminate frequent cleaning.

Representatives: A. E. Armstrong, president; T. H. Rea, sales manager; O. E. Ulrich, factory representative.

Atwood & Morrill Co. Booths 144-148
Salem, Mass.

In this exhibit, which will be found in the space of Ernest E. Lee Co., will be included a continuous discharge trap for draining condensate, an adjustable type of pressure control unit, two types of bleeder extraction check valves and the details to show the construction of a valve, a small line of strainers and custom specialties.

Representatives: C. P. Atwood, treasurer; J. H. Leggett.

Auburn Stoker Corp. Booths 194, 195
Auburn, Ind.

Here will be found the new Auburn automatic fireman underfeed stoker, adaptable to low set and internal firebox boilers. It is of ram feed type, actuated by hydraulic pressure.

Representatives: B. O. Fink, president; Robert L. Fitzgerald, sales manager; John S. S. Fulton, chief engineer; F. D. White, field representative; Geo. W. Heald, Chicago representative.

Barco Manufacturing Co. Booths 112, 113
1801 Winnemac Ave., Chicago, Ill.

Products shown here will include Barco flexible joints, swivel joints and lubricated plug valves in various sizes. Special features will be electrically-operated moving models covering flexible joints and swivel joints on platen presses and other applications.

Representative: J. T. Ross, in charge.

Barrett-Christie Co. Booths 401, 403
108 N. Clinton St., Chicago, Ill.

This company will have a display of Armstrong steam traps, Lumen machine bronze, Wood Shovel and Tool Co.'s shovels and scoops, Durabla sheet and rod packings and high pressure gage glasses, Instant Water Heater Co.'s products.

Representatives: Henry Barrett, president J. D. Christie, secretary and treasurer; C. M. White; W. J. Sprenkle; S. O. Olsen, H. B. Westphal.

Walter Bates Steel Corp. Booth 190
Gary, Ind.

Models illustrating the various types of transmission towers and steel poles, also sections of steel floor grating and stair treads and samples showing the material from which these are built, also details of a unique mechanical joint will be displayed.

Representatives: H. G. Walter; J. H. Williams; Lon Sloan, sales manager, grating division.

Bayley Blower Co. Booth 29
732 Greenbush St., Milwaukee, Wis.

Products shown in this exhibit will be the Bayley turbo air washer, complete with heater, fan and motor; various types of fan wheels; Discfin unit heater; Chinookfin heater section. As special features will be the turbo air washers, demonstrated in operation.

Representatives: C. S. Schaefer, Chicago manager; L. A. Volberding, Chicago.

Bearium Bearings, Inc. Booth 318
261 Franklin St., Boston, Mass.

Products shown here will include sample castings of Bearium metal, cored and solid bars and Bearium processed rods. Several pieces of machinery loaned by prominent manufacturers and showing the bearings in actual service, will make up a special feature of the display.

Representatives: E. P. Langworthy, vice president; G. H. Kendall, chief engineer.

Bentz Engineering Corp. Booth 14
661 Frelinghuysen Ave., Newark, N. J.

Special features of this exhibit will be a small model of the Chillblast for building air conditioning and the Radi-Mist, a household radiator humidifier. The Chillblast will be equipped with the regular cooling coils, Bentz impingement sheds and blower, pump and motors. Radi-Mist is a household device to be placed on radiators to give large evaporation of water from wicks for humidifying the air in the room and equipped with automatic ball float to keep the humidifier supplied with water.

Representatives: W. E. Lowell; V. Cano; R. P. Rasmussen, western manager; Alan Perkins; F. M. Collins.

Bethlehem Steel Co. Booths 203, 204
Bethlehem, Pa.

Exhibits to be found here will include the Bethlehem pulverizer, Dahl oil burnign system, Weir type of turbo-feed pump and a special demonstration of the Bethlehem Dahl oil burner, showing actual operation by the use of a spray of colored liquid.

Representatives: H. B. Pearson, Jr.; C. H. Johnson; I. D. Groak; W. B. Pritchard.

Bigelow-Liptak Corp. Booth 4
5057 Woodward Ave., Detroit, Mich.

Products here shown will include the Bigelow suspended wall and arch, Liptak type X wall, also single and double Liptak supsension arches. Details of construction will be shown and installations fully illustrated.

Representatives: W. D. Dreiske; A. V. Chichester.

Blaw-Knox Co., Booths 137-8
Pittsburgh, Pa.

The Andrews-Bradshaw Division of the company will exhibit the action of the Tracyfier by an entirely new method. The drum type Tracyfier will be shown for the first time at any power show in an arrangement placed in a separate drum, the drum being located at a convenient point in the steam line, either directly above the steam drum, or elsewhere, as conditions may dictate. Other arrangements of the Tracyfier will also be exhibited.

Representatives: Roger W. Andrews; Ralph N. Robertson; J. Lucien Jones.

Boiler Engineering Co., Booth 64
931 Federal Trust Bldg., Newark, N. J.

Here will be found Turner and Beco baffle walls with method of installation and data to show effectiveness in securing efficient combustion and handling. Photographs and working drawings will show installations that have been made by the company.

Representative: J. W. Putnam, vice president.

Botfield Refractories Co., Booth 123
Swanson and Clymer Sts., Phila., Pa.

Adamant fire brick cement, Adachrome, Adachrome fines, Adapatch and the Ada-

mant gun will be the products shown in this exhibit. As special features will be found a structure bonded with Adamant fire brick cement, air set; also fired specimens of Adamant-Adachrome fines mixes and fired specimens of fire brick structure bonded with a 1-2-½ mixture and faced with a 1-3-1 mixture of Adamant-Adachrome fines.

Representative: W. B. Smith.

S. F. Bowser & Co., Inc., Booth 44
Fort Wayne, Ind.

This company's exhibit will consist of its standard line of lubrication and filtration equipment, also a positive piston-displacement Xacto meter. As a feature will be a new force feed lubricator, designed to eliminate the possibility of air getting into the feed lines.

Representatives: L. W. Kohler, manager of lubrication and filtration sales; J. A. Merrill, Chicago district manager; C. J. Worden, advertising manager, in charge.

The Bristol Co., Booth 309
Waterbury, Conn.

Recording and indicating instruments for power plants, including measurement of pressure and vacuum, temperature, water level and electrical values will be found here. A special feature will be thermometers for feedwater and flue gas, also pyrometers for use in Diesel engines and liquid level gages for tanks and boilers.

Representatives: L. G. Bean, Chicago district manager; H. A. Graff; F. W. Chase; H. W. Moss.

Brown Instrument Co., Booths 16, 17
Philadelphia, Pa.

Flush type power plant instruments will be mounted on black metal panels, including pyrometers, pressure gages and recorders, carbon dioxide meters, manometers, thermocouples and automatic control valves. A 4-ft. flow meter will show the method of operation of the inductance bridge principle. Instruments will be shown in indicating and recording types, many of them in operation.

Representatives: G. W. Keller, sales manager; C. L. Saunders, Chicago manager; P. R. Manfre; W. D. Rolfe, St. Louis manager.

The Brownell Co., Booths 169, 170
Dayton, Ohio.

Brownell single retort, side dump, underfeed stokers will be shown, also type A-1 automatic underfeed stokers and a Brownell Master welded boiler. Another feature will be a Fuel Savr. The underfeed stokers are of plunger feed with auxiliary rams to carry fuel forward in the coal retort. The Fuel Savr is a house heating boiler designed for fuel economy and durability, of vertical type and the Master welded boiler is for larger domestic heating with either gas or coal, for incineration of garbage and for the furnishing of hot water supply.

Representatives: H. E. Seabold, general sales manager; H. M. Swindler, in charge of exhibit; R. J. Kempter.

Buffalo Forge Co., Booths 120-122
Buffalo, N. Y.

The feature of the exhibit in this booth will be the new Buffalo centrifugal washer. This is designed for efficiency for any process in elimination of dust and is particularly applicable for powdered coal installations to prevent pollution of the atmosphere.

Representative: E. Lynn Hubbard.

Burnham & Lindsey, Inc., Booths 158, 159
565 W. Washington St., Chicago, Ill.

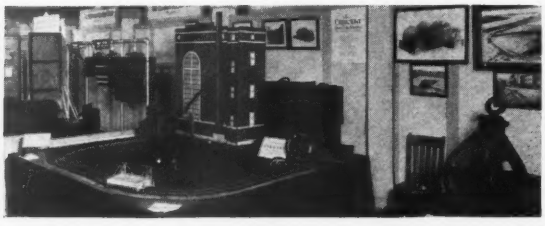
This firm will exhibit products of the Centrifix Corp. and the Vulcan Soot Cleaner Co., including steam purifiers for boilers and evaporators, separators, deconcentrators and soot blowing apparatus with Vulcan valve-operating heads.

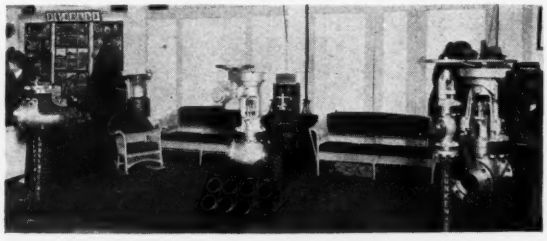
Representative: C. L. Burnham.

The Carborundum Co., Booths 186, 187
Perth Amboy, N. J.

In this space the exhibit will consist of a section of boiler showing water-tube side walls protected with Carbofrax brick and an air cooled end wall constructed of Carbofrax brick, designed for powdered coal firing at high rating. In addition, will be displayed details of design of Bernitz-Nygaard Carbofrax brick protection for water-wall construction under boilers, also an air cooled Carbofrax wall designed to take care of difference in expansion between Carbofrax and fire clay.

Representatives: S. A. Fenno, assistant sales manager; R. A. Beverley, R. A. Barr, sales representatives; E. W. Woodruff, of The Refractory Products Co.





Carrick Engineering Co., Booth 312
538 S. Clark St., Chicago, Ill.

Products exhibited here will be hydraulic and electric types of combustion control equipment. A special feature will be made of a model showing the method of operation of Carrick mercury actuating medium for this equipment.

Representatives: John G. Hollmeyer; B. A. Weimer; C. B. Stewart.

Carter Bloxonend Flooring Co., Booth 58
902 Walnut St., Kansas City, Mo.

Flooring panels made of standard 8-ft. lengths of Bloxonend flooring will be shown, this material being widely used in industrial plants. Its construction insures a lastingly smooth trucking surface as the wear is against the end of the grain.

Representatives: J. G. Galvin, advertising manager; A. E. Giese, Chicago representative; John Thomasma, installation superintendent, Chicago.

A. W. Cash Co., Booth 168
Decatur, Ill.

Aluminum models of the complete line of Cash standard reducing and regulating valves will be shown with a large number of types and sizes of stock valves. Working exhibit will be made of the various regulators in the Craig system of automatic combustion control including a full size master controller, draft regulator and a fan engine regulator with accessory equipment. Among the products shown will be valves in pressure-reducing and regulating types for air, oil, hot and cold water, steam and gas; valves for pressure relief and for vacuum relief, also for ammonia expansion and control; regulators for fan engines and dampers; strainers, pump governors and other steam specialties.

Representatives: H. H. Shugart, general manager; C. M. Terry, chief engineer; C. C. Fremon, sales manager; C. W. Court, manager combustion control division; W. R. Reitz of Reitz Sales Co., Chicago representatives for valves; J. F. Meyer, Meyer-Ekstrom Co., Chicago representatives for combustion control.

Centrifix Corporation, Booths 159, 160
3029 Prospect Ave., Cleveland, Ohio.

In this exhibit will be found steam purifiers, line separators for steam and compressed air, evaporator units, and other similar equipment. As a special feature, will be shown the Centrifix deconcentrator, one of the most recent developments of the company's products, which operates on the continuous blowoff principle with limited waste of boiler water.

Representatives: L. C. Kerner; O. P. Warner; C. L. Burnham; Geo. von Haase.

Chicago Rhopac Products Co., Booth 205
925 Wrightwood Ave., Chicago, Ill.

Complete line of flexible metallic and standard types of packings for rods, plungers and valve stems will be shown, also sheet packings and gaskets made from asbestos, duck and rubber and a line of molded mechanical rubber goods such as hose, belting, diaphragms, pump valves, valve discs and seats.

Representatives: L. L. Ryan, general manager; W. M. Skinner; A. R. Howard; W. R. Lewis; George Field; A. D. Hubbard; C. L. Hilliard.

Clements Mfg. Co., Booth 317
601 Fulton St., Chicago, Ill.

This company will exhibit a complete line of Clements Cadillac portable electric blowers in a wide range of sizes, with attachments for performing cleaning operations of all kinds by either blowing or suction. As a special feature will be shown a new adaptation of blower, the portable gas-electric blow-torch which will give a quick heat up to 2300 degrees F. by simply turning on gas and electricity and applying a match.

Representatives: W. J. Clements, vice president; C. A. Bremmer, manager blower division; O. E. Prellwitz.

The Cleveland Worm & Gear Co., Booth 57
3249 E. 80th St., Cleveland, Ohio.

This exhibit will include standardized worm gear reduction units and high-efficiency worm gearing for industrial and automotive service.

Representatives: Ralph R. Day, sales engineer; John D. Kinsey, Chicago manager.

Clipper Belt Lacer Co., Booth 436
Grand Rapids, Mich.

Here will be found the entire Clipper line consisting of various models of belt lacers, including the new speed lacers Nos. 6 and 8 and the new 10-in. model belt cutter. Special features which will attract attention will be an electric window display representing a ship sailing the high seas and emphasizing the name of the company.

Representative: G. E. Farmer, in charge.

Cochrane Corporation Booths 174, 175
17th St. below Allegheny Ave., Phila, Pa.

Cochrane products exhibited in this space will include the V-notch recorder, steam purifier, discharger, forged steel tandem blowoff valve and multiport back pressure valve. The recorder, for indicating, recording and integrating the flow over weirs, is cam-operated from a float with the complete mechanism supported by one casting so that it can be removed as a unit from the case. The steam purifier is of the receiver type for removing water and suspended solids from steam. The discharger has a pilot-operated main valve, the pilot valve being operated by a displacement body moved by the water in the trap. Blowoff valves have two valves in tandem in a single forged steel body, one of these being of rotating gate type which must be lifted from its seat before it can be turned and the other having a sealing disk which is also moved from its seat by means of a bypass pressure valve before opening and closing. In the back pressure valve, several small disks are used, each having a dash pot and being held to its seat by an independent spring, with the tension of all the springs adjusted simultaneously by means of a pressure spring.

Coen Co., Inc. Booth 191
112 Market St., San Francisco, Cal.

This exhibit space will be devoted to oil burning equipment and will have as a main feature the Tri-Fuel front which can be used for any of three fuels without changes, thus permitting change to gas, fuel oil or powdered coal, according to circumstances. It will be equipped with a mechanical type A burner, socket, flexible hose, thermometers, and gages. Other equipment to be seen at the exhibit will include suction and discharge strainers, mechanical, flat flame steam, round flame outside mixer steam and venturi hood burners, flexible hose, burner tips and springs, caps and burner rod ends, white and black enamel Ellcon pipe and fittings and photographs of apparatus and information.

Representatives: Charles B. Smith, sales engineer; F. S. Harper; J. D. Rankin.

Combustioneer, Inc., Booths 231, 232
1829 S. 55th Ave., Chicago, Ill.

Products in this exhibit will include the Combustioneer automatic coal burners and cut-away parts as well as complete assemblies of the equipment.

Representatives: W. S. Burke, sales manager; R. C. Goddard; J. T. Mabee; F. A. Doyle; W. E. Lloyd; J. H. Newman.

Connery & Co. Booths 156-7
Second St. above Erie Ave., Phila., Pa.

Products to be featured will be Connery's Improved Expansion Stiffened breechings and air ducts, improved air cooled damper, improved stack connection, improved covering attachments for breechings, and section of forced draft duct indicating the use of blades or vanes as proved most efficient at the works of the General Electric Co. This latter will be a special feature as it is practically a new development.

Representatives: W. M. Connery; A. H. Chas. Dalley; W. J. Henderson.

Consolidated Ashcroft-Hancock Co., Inc. Booth 22
100 E. 42nd St., New York, N. Y.

Here will be found a full line of products of the company including Ashcroft control valves and pressure and vacuum gages for pressures up to 1500 lb.; Hancock cast steel and forged steel valves in all types, for pressures up to 1350 lb.; Consolidated cast iron and cast steel pop safety valves, economizer relief valves and the like for pressures up to 1500 lb.

Representatives: W. P. Bradbury, sales manager; Charles Stepan, western manager industrial sales; M. S. Palmer; W. Loos.

Cooke Seal Ring Co. Booth 193
30 No. Green St., Chicago, Ill.

Demonstration will be made of the Cooke seal ring in actual operation, application being shown to a high pressure pump and to a horizontally split multistage pump. A refrigerating machine manufactured by the Cooke Electric Refrigeration Co. with use of seal rings will also be shown.

Representatives: George J. Cooke, Sr.; George J. Cooke, Jr.; Robert E. Cooke; B. L. Clutier; Roland Barlow; Charles Foley.

Coppus Engineering Corp. Booth 94
Worcester, Mass.

Here will be found one of the company's man-cooling fans, the Heat-Killer and its boiler cooling fan, the Manhole Blower. There will be also a display of the company's regular line of blowers, boiler feed pumps and steam turbines and examples of aluminum, brass, bronze and monel metal castings.

Representatives: H. Himelblau; T. Agazim.

Crosby Steam Gage & Valve Co.,
30 Church St., New York, N. Y. Booth 211

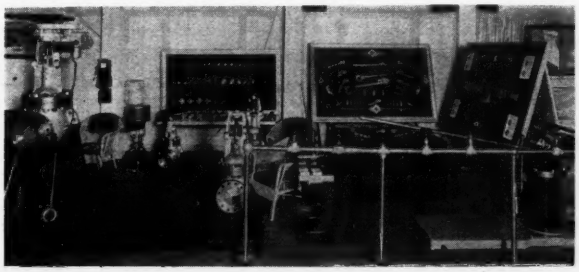
Here the main feature will be gages and safety valves for all presures and in all sizes, also a line of relief and blowoff valves, indicators and whistles and a gage-testing machine for pressures up to 25,000 lb.

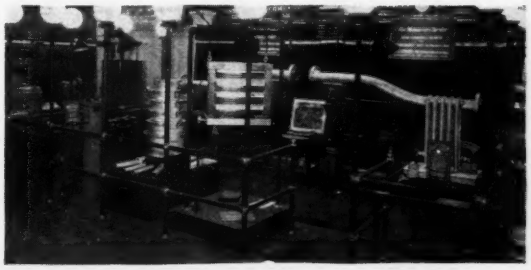
Representatives: E. V. Kenyon, assistant general sales manager; E. W. Zimmerman, Chicago representative.

The Cutler-Hammer Mfg. Co., Booths 106-108
12th & St. Paul Ave., Milwaukee, Wis.

Here will be found on display a variety of motor control apparatus, including alternating and direct-current automatic starters, control apparatus for use in large buildings, motor-operated valve control, wiring device products, tubular and space heaters, resistors and various types of motor control accessories. Outstanding as a feature among these products will be the new Cutler-Hammer unbreakable resistor known as DUR-ristor, also a new alternating current speed regulator with magnetic primary contractor and thermal overload protection, a new water-level alarm system giving automatic indication of high or low water level for fire pump systems and a new type alternating-current, motor-operated valve control for small size valves up to 6 in. diameter.

Representatives: C. J. Maloney, Chicago district manager; F. J. Burd, Chicago; F. U. Webster, L. P. Niessen, Milwaukee.





The Dampney Company of America,
Hyde Park, Boston, Mass. Booth 100

This company will exhibit its complete line of Apexior protective coatings for metal surfaces and will show the equipment that has been developed for applying this coating expeditiously to the internal surfaces of boiler, economizer and condenser tubes and other types of power plant equipment. Available for inspection will be a number of samples of boiler tubes that have been pickled for the removal of mill scale and later Apexiorized, showing the condition of the coating after various lengths of service under operating conditions.

Representatives: E. F. Gilbert, president; D. H. Skeen & Co.

G. M. Davis Regulator Co., Booth 82
422 Milwaukee Ave., Chicago, Ill.

This display will include automatic valves for pressure regulation, also nonreturn valves for bleeder lines and turbines and for special pressure and back pressure regulation.

Representatives: George C. Davis, president; J. C. Kinsley; George Hochmeister; Harvey Willard.

Dearborn Chemical Co., Booth 80
310 S. Michigan Ave., Chicago, Ill.

Dearborn products will be specially featured, including boiler feedwater treatment; treatment for domestic hot and cold water systems; treatment for rapid removal of scale from heaters, condensers, internal combustion engine cooling jackets and double pipe condenser coils; powdered cleaners for cleaning floors, metal parts and drain parts. Other features of the display will be No-Ox-Id for rust prevention and a display of lubricating oil for power plant and industrial use, also for automobile lubrication. Products will be demonstrated and their effectiveness fully shown.

Representatives: J. W. Harkins; M. M. Kutzer; H. M. Harrison; E. Redman; A. C. Herrmann.

The DeLaval Separator Co., Booth 47
165 Broadway, New York, N. Y.

Oil purifying and dehydrating equipment as used for lubricating, fuel and transil oils will be exhibited here. A special feature will be the new No. 700 portable oil purifier of high capacity and embodying a complete unit of its type.

Representatives: C. B. Schmidt, sales manager, Chicago; J. G. Hamilton, N. E. Larsen, A. R. Rose, E. H. Croisant, H. M. Beach, sales engineers.

A. P. deSanno & Son, Booth 341
1615 McKean St., Philadelphia, Pa.

This company will exhibit its Radiac cut-off machine for cutting materials by the use of abrasive wheels. It is suitable for cutting tubing, bar, round or flat stock of soft iron, nickel or high speed steel, monel metal and other materials.

Representatives: Benjamin Hardy; L. E. Buckingham.

M. H. Detrick Co., Booths 182, 183
140 S. Dearborn St., Chicago, Ill.

Detrick arches and walls will be shown here, including the sectional supported wall with natural air ventilation and cooling. Full size model will be shown of the Detrick arch and photographs of installations.

Representative: R. D. Foltz, vice president.

DeWalt Products Co., Booth 223
Leola, Pa.

DeWalt products, including the Wonder-worker saw equipment for contractors, the portable band saw, the jointer and the mortiser will be displayed. The Wonder-Worker is a circular saw, motor-driven, which can be changed quickly from cross-cutting to ripping and has other tool attachments to be driven from the arbor.

Representative: Paul Gardner, president, in charge of exhibit.

Diamond Power Specialty Corp.,
Detroit, Mich. Booths 178, 179

In this exhibit the company will have models of its Diamond Automatic Valv-in-Head blower for water-tube boilers, models F and B blowers for horizontal return tubular boilers and model I blower for radiant superheaters. A special feature will be moving pictures illustrating the operation of soot blowers installed on a water-tube boiler.

Representatives: W. P. Thomas, secretary; G. L. Davis, assistant sales manager; E. K. Uebe, C. L. Conrad.

Drake Non-Clinkering Furnace Block Co., Inc., Booth 147
5 Beekman St., New York, N. Y.

This exhibit will be a part of the general exhibit of the Ernest E. Lee Co., and will include the Drake SX air-cooled wall designs A and B and the Drake air-cooled floor, designed to utilize the laws of heat transfer so as to give effective preheating as well as air-cooling. Another feature in the exhibit will be an improved combustion system which is an application of air-cooled walls for smoke abatement; also the Drake water wall construction will be shown.

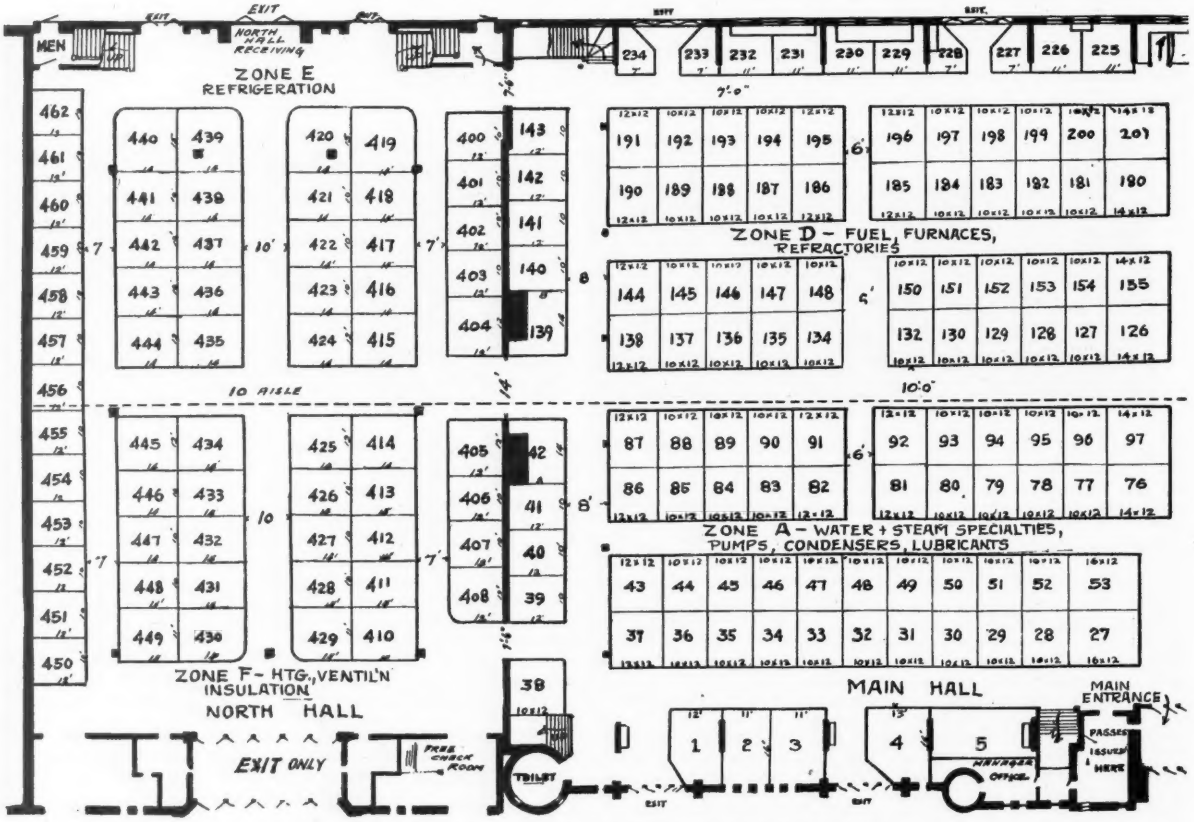


FIG. 1. NORTH HALL AND NORTH HALF OF MAIN HALL

Durametallic Corp. Booth 410
Kalamazoo, Mich.

Semimetallic packings including Durametallic spiral rod and die-moulded ring sets; Dura plastic rod. All in six grades to make a complete packing service.

Representatives: C. C. Hall, vice-president; J. M. Bandish, midwestern sales manager; Roscoe R. Smith, sales representative.

Economy Pumping Machinery Co., Booth 439
3431 W. 48th Place, Chicago, Ill.

Products shown in this space will include a 6-in., high efficiency, single-stage centrifugal pump of 1200 g.p.m. capacity at 100 ft. head and 85 per cent efficiency;

4-in. single-stage, high-efficiency pump of 550 g.p.m. capacity at 100 ft. head and 78 per cent effciency; a 1-in., multi-stage centrifugal pump of 30 g.p.m. capacity for 150 lb. pressure; a 2½-in. multi-stage pump of 175 g.p.m. capacity at 200 lb. pressure; a 2-in. standard automatic sump pump of 100 g.p.m. capacity at 25 ft. head and a 4-in. open-shaft, non-clogging sewage pump of 300 g.p.m. capacity at 35 ft. head. As a special feature of the display will be found a horizontal centrifugal pump in operation with complete set of nozzles and gages to demonstrate the action and efficiency.

Representatives: R. H. Thomas, president; L. G. L. Thomas, vice-president; W. W. Huggins, secretary; H. R. Ryan, sales manager; A. L. Welsh, F. W. Jackson, J. F. Sass, Randall Grady, sales engineers.

Ehret Magnesia Manufacturing Co., Valley Forge, Pa. Booth 90

Samples of Ehret's 85 per cent magnesia products, high temperature insulations and other insulating material in sectional and block forms will be found in this exhibit. Varying combinations to meet different conditions will be shown and the effectiveness of the installation demonstrated.

Representatives: H. G. Hill, technical engineer; Lawrence L. Shailer, Chicago branch manager, in charge.

Ellison Draft Gage Co., Booths 5, 6 214 W. Kinzie St., Chicago, Ill.

In this exhibit the Ellison draft gages of tube and pointer types will be shown in various forms and arrangements. Steam calorimeters and Pitot steam tubes will also be shown. The special feature of the exhibit will be pointer draft gages for high readings, mounting of gages for combination work, a new mercury gage with straight line movement for high drafts.

Representatives: Lewis M. Ellison, Alanson F. Smith, Martin Coco.

Erie Heating Systems, Inc., Booth 445 Erie, Pa.

This company's exhibit will consist of a complete line of industrial unit heaters and a display of blast coil assemblies for heating and process drying work. Specially featured will be the new Erie concealed blower unit for commercial, institutional and domestic heating service.

Representatives: W. L. Mack, president; E. J. Vermere, chief engineer; W. R. Montgomery, F. H. Montgomery, Chicago office.

The Fafnir Bearing Co., Booths 334, 335 New Britain, Conn.

Ball bearings in a complete line covering single row radial, double row, thrust and other types, also a line of transmission equipment, including hanger boxes, pillow blocks, fan boxes and loose pulleys will be shown. A wide inner ring bearing and self-locking collar will be exhibited and a moving display will demonstrate the frictionless operation of ball bearings and the saving in power by their use.

Representatives: H. R. Reynolds, chief engineer; C. F. Stanley, assistant manager industrial bearings division; R. M. Ring, manager Chicago office; T. C. Waddell, sales engineer, Chicago; C. W. Kramlich, Milwaukee.

Fairbanks, Morse & Co., Booths 126, 127, 154, 155 900 So. Wabash Ave., Chicago, Ill.

This company will display a 40-kw. Diesel engine generating set, a Fig. 860 centrifugal pump in operation, a sectionalized 3-in. Fig. 850 pump, a Fairbanks-Morse Price turbine pump, a Fig. 520 pump, a sectionalized Type H motor running by air, a Type H motor, a Type DH motor, a sectionalized Type HAC motor, a single-phase motor and a Type UHL motor. Besides these products, other features of the exhibition will include a number of enlarged photographs of the Fairbanks-Morse products.

Representatives: A. C. Dodge, manager, Chicago branch; C. W. House; M. B. Brister; W. B. Covington; R. V. Cook; J. S. King; Earl Chambers; R. M. Kinney; E. C. Morton; C. B. Stibolt; S. J. Eaton.

The Fisher Governor Co., Inc., Booth 35 Marshalltown, Iowa.

This company will display steam traps, pressure reducing valves, relief and back pressure valves, pump governors, boiler fuel governors, boiler excess pressure pump governors, strainers, liquid level controllers, and pilot-operated control valves. As a new feature will be shown the Fisher Master pilot-operated control valve, consisting of an auxiliary reducing

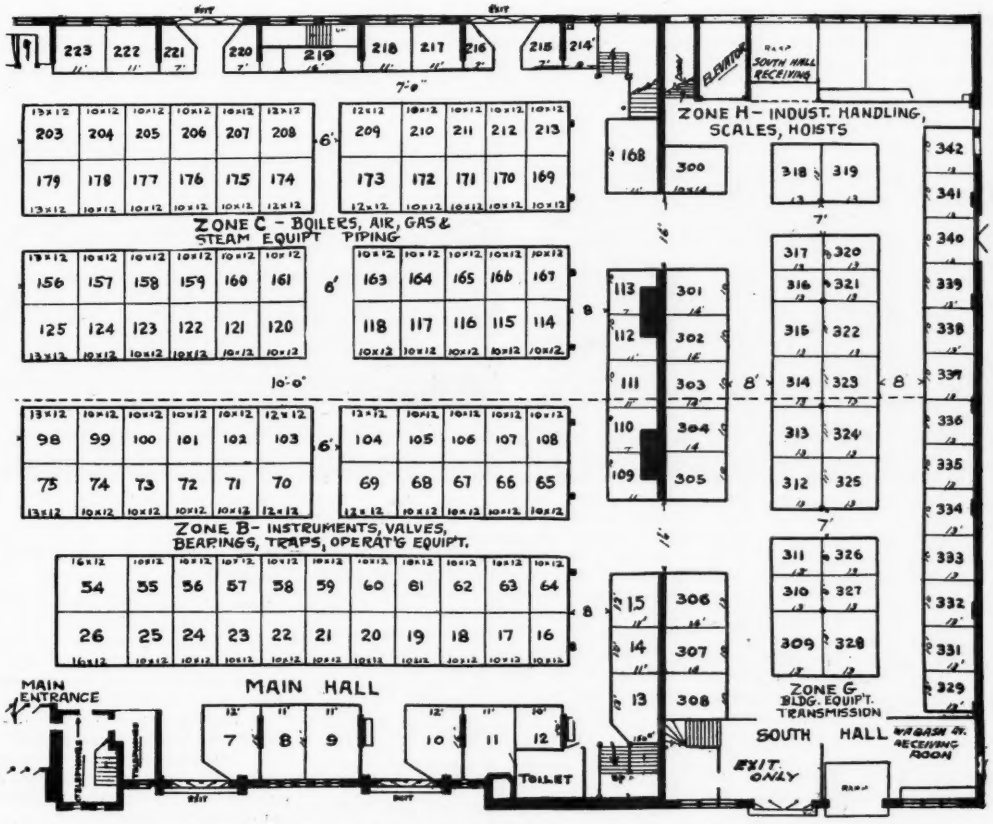

ZONE H – INDUST. HANDLING, SCALES, HOISTS
ZONE C – BOILERS, AIR, GAS & STEAM EQUIPT PIPING
ZONE B – INSTRUMENTS, VALVES, BEARINGS, TRAPS, OPERAT'G EQUIPT.
MAIN HALL
MAIN ENTRANCE
TOILET
SOUTH HALL
EXIT ONLY
ZONE G BLDG. EQUIP'T. TRANSMISSION
SOUTH HALL RECEIVING
ELEVATOR

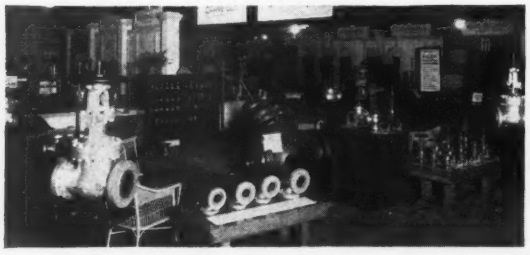
FIG. 2. SOUTH HALF OF MAIN HALL AND SOUTH HALL

valve, strainer and control valve of compact form. Study will show its efficient and sensitive operation and a unit will be shown in working action with recording charts to register results. Variable initial pressure will be supplied by an air compressor and, with variable flows, the action of the master unit under service conditions will be illustrated. Another feature will be a type No. 519 boiler gas fuel governor, illustrating the operation and construction of the type No. 777 pilot control without need of auxiliary pressure or regulators, designed for elimination of flow pressure loss.

Representatives: L. W. Browne, vice president; J. F. Hallowell; P. A. Elfers.

Flynn and Emrich Co., Booth 225, 226
Holliday & Saratoga Sts., Baltimore, Md.

This company will display one of its type AH Huber stokers, of strictly automatic type with heavy duty grate surface. This will be set up exactly as it will be installed under a steam boiler of



700 hp. but cannot, of course, be shown in operation under steam or water pressure. There will, however, be an auxiliary water pressure system, electrically driven, to show the operation of the stoker except so far as fuel is concerned. Other features will be photographs, results of evaporative tests and detailed parts of the stoker.

Representatives: Henry H. Hyde, sales manger; Charles J. Huber, Baltimore; Bert B. Williams, Guy E. Williams, Loren L. Hebberd, Chicago office; Gustav J. Kordula, Milwaukee; Gordon Simmons, Cleveland; D. L. Healy, D. W. C. Ruff, St. Paul.

Forced Underfiring Corp., Booths 197, 198
570 W. Randolph St., Chicago, Ill.

Products to be displayed here will be industrial and household sizes of Iron Fireman stokers. A new feature will be the new De Luxe Iron Fireman, or small household stoker, a machine smaller than the Iron Fireman, Jr.

Representative: Mayne Read, sales manager.

Foster Wheeler Corp., Booths 180, 181
165 Broadway, New York, N. Y.

As most of the products of this concern are heavy machinery, the showing of full size equipment is limited, but all apparatus will be illustrated by enlarged photographs, drawings, sections of construction and models built to scale. The exhibit will include Aero unit pulverizers, Wheeler condensers, cooling towers, feedwater heaters, evaporators and steam jet air pumps shown through illustrations and drawings; also sections of Foster superheaters, economizers, sectional air heaters, water backs and water walls of standard construction as used in actual installations. A striking feature will be a model to scale of four air heater sections for assembly into various arrangements of series and parallel flow with a section of air heater construction, full size and of standard materials. An exhibit of Crescent Brand brass and copper tubing and piping will show the high ductility and tensile strength of the material.

Representatives: T. H. Wilkins, in charge; W. F. Meyer, O. H. Anderson, Kenneth Bedell, P. R. Greenman, Arno Dietze, J. K. Seabright, E. H. Chapin, engineers.

The Foxboro Co. Booths 55, 56
Foxboro, Mass.

A representative exhibit will be made of indicating, recording and controlling instruments. The background of this display will be a 13-part cold rolled steel gage board, on which will be mounted a typical Foxboro power plant layout, including boiler level indicator, duplex indicating thermometer for feedwater, three-pen recording thermometer for generator air, combination recording thermometer and gage, and other equipment. These instruments will exemplify latest improvements in design such as push button, tension-type chart hub, pivoted movement, micrometer adjusted pointers and pen-arms and detachable pen-arms. As a special feature, one of the new Foxboro mechanical type steam flow meters with integrator will be shown in operation on a typical steam line installation. The cover of the meter will be of glass to show direct transition of motion from the float to the pen-arm.

Representatives: C. H. Roessner, manager Chicago office; Messrs. Stewart, Burnett, Hayden, Nowland, Chicago.

O. E. Frank Heater & Engineering Co.
20 Milburn St., Buffalo, N. Y. Booth 63

Equipment to be exhibited here will be the OEF oil cooler and heat exchanger, which is a new patented design with permanent pipe connections and test ring. The shell and liquid channel box are cast integral so that the tube bundle may be removed without breaking pipe connections or ports. By means of the annular test ring, units can be cleaned or a tube replaced without removing the tube bundle.

Representatives: Mrs. O. E. Frank, president; H. P. Wilder, vice president; Harry Himelblau, manager Chicago office.

Furnace Economy Co. Booth 196
407 S. Dearborn St., Chicago, Ill.

The features in this display will be Economy air-cooled blocks, showing sectionally supported walls, clinker line blocks and built up walls.

Representatives: M. C. Neil, H. B. Lynde.

The Garlock Packing Co. Booth 15
Palmyra, N. Y.

This company's general line of Quality-Controlled mechanical packings will be displayed, also as a special feature, metal oil return packing for use on gas engines, air compressors, gas compressors. steam engines, Diesel engines and any type of machine with enclosed crank case. Another feature of the exhibit will be a new product known as Chevron packing, especially designed for heavy duty.

Representatives: J. F. Franey, S. H. Flannigan, B. F. Cameron, L. H. Bryan, C. C. Wiffin, E. A. McClay, C. E. Leverenz, E. C. Johnson, C. F. Palmer, A. F. Sheldon, A. F. Myer, sales representatives

Graver Corp. Booth 91
East Chicago, Ind.

This company will display its water treating and filtering equipment, steel plate construction work and the Kidwell boiler. A special feature will be an actual size meter control equipment for lime-soda water softeners in operation to demonstrate accuracy and simplicity of this new equipment which has been developed during the past year.

Representatives: Joseph C. Winslow, manager sales promotion; J. J. Felsecker; W. M. Gross; E. S. Thayer.

The Green Fuel Economizer Co.
Beacon, N. Y. Booth 172

Products on exhibit here will be models of air preheaters of tubular and plate type, Cindertrap and Dustrap, the latter having been recently introduced for collecting ashes thrown out by powdered fuel plants. The construction is of steel plates with supports and angles as stiffeners, the plates being suspended to form narrow, vertical nozzles, alternating with expansion chambers and the dust dropping from the bottom of the plates into sectionalized hoppers.

Representatives: R. N. Turner; F. Trott.

Grinnell Co., Inc. Booths 96, 97
Providence, R. I.

Here will be found the Grinnell fabricated piping, pipe bends, lap joints, pipe hangers, three sizes of Thermoliers, Equiflo valves, Lux fire extinguishing equipment and other products of the company.

Representatives: J. V. Pryor, vice-president; John B. Coleman, chief engineer; Howard E. Branch, publicity and promotion department; F. M. Daugherty, central district manager; C. W. Little, supply subdivision, Detroit.

Arthur Harris & Co. Booth 214
210 N. Curtis St., Chicago, Ill.

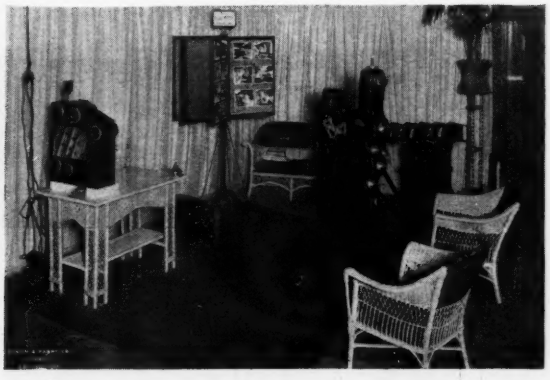
Items included in this display will be special copper coils, HarBronz bushings, exansion joints and copper special floats.

Representatives: A. J. Harris, G. C. Harris, A. W. Baumann.

The Hays Corporation Booth 314
Michigan City, Ind.

New equipment to be featured in this space will be the model C Hays combustion meter and the improved Hays boiler panel. The new Hays improved gas analyzer will also be shown. Other equipment to be exhibited will be a line of pointer type draft and pressure gages, U-tube direct reading, inclined tube and multi-tube direct reading gages. The new combustion meter is furnished to record carbon dioxide in combination with either furnace or flue gas temperature or all three can be included in the one instrument. The boiler panel is built to suit the requirements of a particular plant with instruments mounted in a metal enclosure, having doors to allow access to the valves, pipes and wiring of the various instruments.

Representatives: Phil T. Sprague, president; Shirl M. Rudolph, director of sales; J. W. Murphy, Illinois representative: J. T. Vollbrecht, W. H. Pugsley of J. W. Murphy Co.



E. Vernon Hill Co. Booth 454
121 No. Clark St., Chicago, Ill.

Air testing instruments will be found here, especially combination wet and dry bulb thermometers, psychrometers and Pitot tubes. The Aerologist, a publication, will also be displayed.

Representatives: E. V. Hill; P. J. Marschall; E. B. Stark.

Himelblau, Agazim & Co. Booths 63, 64
30 N. Dearborn St., Chicago, Ill.

Products will be displayed of the various companies which this firm represents in the Chicago territory. These will include the Boiler Engineering Co., manufacturers of Beco and Turner baffles for water-tube boilers, with expansion joint; Boiler Room Improvement Co., manufacturers of Eclipse smoke indicator, McNeill liquid level gages and draft gages; Clip-Bar Manufacturing Co., manufacturers of radiator brackets and pipe hangers; W. B. Connor Co., Inc., manufacturers of the Shortt automatic pumping trap, Ace steam trap and DuBus pump; Coppus Engineering Corp., manufacturers of blowers for forced draft and steam turbines; General Air Filters Corp., manufacturers of the Ace automatic and stationary type air filters; Lehnco Co., manufacturers or regulators for boiler operation and house pump service; Littleford Bros., steel plate construction and the Littleford expansion joint for breechings and ducts; Dennis Engineering Co., manufacturers of expansion joints for turbine connection to the condenser; Schade Valve Manufacturing Co., manufacturers of regulating valves; Minwool Insulating Co., manufacturers of felted rock-wool insulation.

Representatives: Harry Himelblau; T. Agazim.

Hoffman Specialty Co., Inc. Booths 437, 438
130 N. Wells St., Chicago, Ill.

Products to be exhibited here will include a complete line of Hoffman venting valves and controlled heat vapor equipment. As special features there will be the new Hoffman electric heater and also condensation and vacuum pumps of the company's manufacture.

Representatives: F. H. Gaylord, assistant sales manager; N. P. Fenner, district office manager; George Washington.

E. F. Houghton & Co., Booths 30-32
240 W. Somerset St., Philadelphia, Pa.

This display will feature Vim leather belting, leather packing, Absorbed oil for lubrication and other Houghton products. Specially featured will be Common-sense belt tests, the application of Vim leather belting to various types of drives, vacuum tests of leather belting, the Houghtometer for comparison of belt performances, Absorbed oils and the application of Vim leather packing. For the most part these exhibits will be shown in operation.

Representatives: J. Coleman Bentley, secretary to the president; G. R. McCormick, technical and editorial department.

Hydroil Corp., Booth 192
Lebanon, Ind.

Oil purifying equipment will be the product displayed in this booth, the details and method of operation of the apparatus being fully demonstrated.

Representatives: D. B. Clark, manager; F. M. Tomlinson, engineer.

Illinois Engineering Co., Booths 405, 406
Racine Ave. at 21st St., Chicago, Ill.

This company will exhibit its line of power plant and heating specialties, featuring a glass model of its Fig. 35, Eclipse steam trap operating under actual steam conditions. In the line of heating equipment there will be featured various items such as radiator valves, traps, boiler room equipment for vapor heating systems and a working model of the zone control valve for heating systems.

Representatives: James C. Matchett, vice-president; J. L. Ehretsman, in charge of booth.

Illinois Stoker Co., Booth 134
Alton, Illinois.

This company will have in its booth a type G forced draft chain grate stoker complete with electric motor drive. It will also exhibit various types of links that it furnishes for both natural draft and forced draft stokers and, as special features, will emphasize the new forced draft stoker drive, a new system of chain cooling which has been developed and a new feature of take-up indicator for the drive shaft.

Representatives: E. E. Lee, J. L. Higgins, Chicago office; C. W. Warinner, Alton.

Ingersoll-Rand Co. Booths 104, 105
11 Broadway, New York, N. Y.

Cameron pumps and special features of Ingersoll-Rand condensers will be shown here, also multi-stage boiler feed pumps for pressures up to 1500 lb. with improved thrust device and Kingsbury thrust bearings.

Instant Water Heater Sales Division Booth 403
332 S. Michigan Ave., Chicago, Ill.

This exhibit will include an Instant copper tube steam water heater and a new Instant low control for steam supplied to the heater. The exhibit will be connected to steam and water lines providing hot water at the booth, with a cut out section to show interior construction.

Representatives: D. F. Priser, general manager Instant Water Heater Co.: H. B. Fridstein, sales manager, Instant Water Heater Sales Division.

International Combustion Engineering Corp., Booths 27-29, 52, 53
200 Madison Ave., New York, N. Y.

Here will be found exhibits by the Combustion Engineering Corp., Heine Boiler Co., Hedges-Walsh-Weidner Co. Dry Quenching Equipment Corp., International Coal Carbonization Co., all subsidiaries of the International Combustion Engineering Corp. The accomplishments of the company's equipment in the burning of pulverized coal and the details of construction of water wall and air cooled walls will be fully demonstrated. Special features will be a Lopulco type D burner for horizontal firing of pulverized fuel, model of water-cooled C-E fin wall, the C-E air preheater, the C-E liquid level indicator and panels showing typical layouts of the company's equipment. Type E stoker will be shown complete and in operation, electrically driven, also a Lopulco unit system pulverizing mill of impact type will show the principal elements.

Representative: J. D. Harrison, Chicago manager.

Irving Iron Works Co., Booths 330, 331
Third and Creek Sts., L. I., N. Y.

Irvico products will be displayed in this

space, including open steel flooring and Safsteps, armoring for highways, bridges and industrial floors, unified reinforcement and armoring construction for concrete slab floors and unified construction for precast concrete crossing slabs, known as Irving Safcross. A special feature will be the armoring for concrete and mastic floors and the reinforcement and armoring for concrete floor slab construction, which will be demonstrated in detail.

Representatives: W. E. Irving, president; P. L. Price, general manager; Wm. Noblett, J. H. Miller, sales representatives; B. O. Buchanan, Chicago district representative.

I-T-E Circuit Breaker Co., Booths 310, 311
19th and Hamilton Sts., Philadelphia, Pa.

Here will be shown circuit breakers and U-Re-Lites in all types and sizes. Of special interest will be a 1,000 amp. full automatic double-throw transfer switch for insuring power and light supply for hospitals and theatres. This changes the circuit from normal to emergency and returns to normal when service is restored automatically. A 2000-amp. generator breaker with direct acting field discharge clips will be another feature and new equipment will be shown including U-Re-Lite all steel distribution groups, circuit breakers and buses totally enclosed in steel.

Representatives: E. Swift Newton, vice president; P. G. Gunion, sales manager.

Johns-Manville, Inc., Booth 209
292 Madison Ave., New York, N. Y.

Processes will be illustrated by which raw material is converted into products of this company such as packing, power specialties, insulation, roofing, electrical material. Types of insulation will be exhibited and demonstration made of the saving effected by the use of such material.

Representatives: E. J. McClure, A. T. Aieselbach; M. Craighead; E. Rock.

W. A. Jones Foundry & Machine Co., Booth 86
4401 W. Roosevelt Rd., Chicago, Ill.

This exhibit will include speed reducers in spur, worm and herringbone gear types. A special feature will be a complete line of these reducers, open to show the details of construction.

Representatives: J. A. Marland; Robert Lemley; J. Cerk; W. LaScelle; James A. Porter.

The Kelly Co., Booths 60, 61
372 W. Grand Ave., Chicago, Ill.

Various sizes of gate valves and a complete line of Kelly self-grinding globe and angle valves will be shown in this exhibit. As a special feature there will be a large 8-in. cutaway working model of the Neway gate valve, operated by an electric drive and showing through the cutaway features the operating advantages of these valves.

Representatives: P. J. Kelly; F. H. Riley; H. Himelblau; T. Agazim; C. W. Foster.

Kennedy-Van Saun Mfg. & Eng. Corp., Booths 217, 218
2 Park Ave., New York, N. Y.

Pulverized coal equipment and transmission machinery will make up the display in this booth. Especially featured will be the "Scene in Action" pictures showing the actual operation of the air-swept tube mill firing the furnace under a boiler; also a picture of the gyratory crusher. Literature about the apparatus will be distributed.

Representatives: T. J. Shearer; Fred Olvey; Guy D. Leopold.

Kieley & Mueller, Inc., Booth 402
34 West 13th St., New York, N. Y.

This exhibit will consist of sectionalized products of the company's steam specialties including especially pressure regulating valves for all purposes.

Representatives: C. H. Dutcher, manager; C. M. White.

William F. Klemp Co., Booth 43
6624 S. Melvina Ave., Chicago, Ill.

This company will display its new Diamonos treads as a special feature and the exhibit will also include Diamond grating and other miscellaneous iron work for power plant construction.

Representatives: A. E. Sangdahl; W. Forrest Ogle, John M. Keown, A. G. Ruge.

The Korfund Co., Inc., Booth 62
235 E. 42nd St., New York, N. Y.

Natural cork plate and the Korfund vibro damper will be exhibited in this booth and demonstration of several special features showing the properties and advantages of these materials will be made.

Representatives: H. Himelblau, S. Rosenzweig.

The LaBour Co., Booth 444
Chicago Heights, Ill.

Primarily this exhibit will feature LaBour self-priming centrifugal pumps with one of the pumps in operation fitted with glass suction lines to demonstrate clearly the ability of the pumps to handle air. In addition, there will be on display a new design of acid valve made of Elcomet metal, also Elcomet castings. This material is an alloy, with physical properties closely resembling steel, which has been developed for corrosion resisting purposes in handling of chemicals.

Representatives: H. E. LaBour; N. A. Pedersen; J. M. Thomas; S. J. Thomas.

The Leavitt Machine Co., Booth 146
Orange, Mass.

Here the company will show a complete line of the Dexter valve reseating machines for globe valves, gate valves and for refacing pump valve seats; also machines which are an entirely new development, for refacing tank car outlet valves.

Representatives: E. S. Hersey, field engineer; Ernest E. Lee.

Ernest E. Lee Co., Booths 134-138; 144-148
115 So. Dearborn St., Chicago, Ill.

This company represents a number of manufacturers in the Chicago district and will have displays as follows: In booth 134 the Illinois Stoker Co., Alton, Ill., showing forced and natural draft chain grate stokers. In booth 135, American Pulverizer Co., St. Louis, Mo., with an operating model of the latest American Ring Roll crusher having roller bearings and tramp metal trap. In booth 136, W. H. Nicholson & Co., of Wilkes-Barre, Pa., with working models of piston-operated trap and weight-operated trap with glass sides, also running model of flexible couplings and section models of each of the above pieces of equipment. In booth 137, Atwood & Morrill Co., Salem, Mass., with different types of bleeder check valves, pilot-operated, single-seated relief valve, condensate drainer and Ezy-Klean strainers. In booth 138, Andrews-Bradshaw Division of the Blaw-Knox Co., Pittsburgh, Pa., with a new working model showing the principle of the Tracyfier and illustrations and samples of the pipe line Tracyfier and the new drum type Tracyfier, differentiating these devices from the sections as installed in the boiler drum. Booth 144, Uehling Instrument Co., Paterson, N. J., with its line of Co_2 instruments and combination vacuum gage and barometer. Booth 145, D. E. Whiton Machine Co., New London, Conn., showing a standard turbine completely equipped with all accessories, including standard packing gland suitable for 50 lb. back pressure, built-in excess pressure governor and a no-water stop. Booth 146, Leavitt Machine Co., Orange, Mass., a complete line in actual working position of Dexter gate valve, globe valve and tank car outlet valve reseating machines. Booth 147, Drake Non-Clinkering Furnace Block Co., Inc., New York, Drake SX wall and also improved combustion system. Booth 148, Northern Equipment Co., Erie, Pa., a new display showing feedwater regulation and complete exhibit of the latest combination feedwater regulator valve and pressure differential regulator, as well as new pump governor and other new developments.

Representatives: Factory executives and engineers from the various companies and for Ernest E. Lee Co., Ernest E. Lee; John L. Higgins; Charles M. Hardin; David V. Grant; Marion T. Jansen.

Leeds & Northrup Co., Booth 21
4901 Stenton Ave., Philadelphia, Pa.

Metered combustion control equipment will be displayed here and also carbon dioxide recorders, indicators, resistance thermometer recorders of the automatic type, generator field temperature record-

ers, multiple point indicating and recording equipment, including instruments and accessories. Ground resistance test set equipped with sechommeter will be a special feature with practically all equipment shown in operation.

Representatives: L. O. Heath, in charge; I. M. Stein; B. F. Keene; D. E. Moat; R. Cleeland; E. S. Bristol.

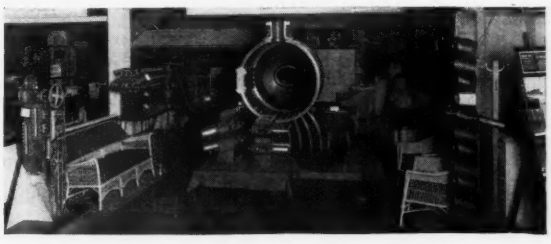
Lehnco Regulator Co., Booths 63, 64
Oak Park, Ill.

This company will have a working model in the space of Himelblau, Agazim & Co., demonstrating the application of its regulator for boiler operation, also for the control of pump speeds and other equipment. The device is for automatic action to control boiler operation, cutting in or out such boilers as may be necessary in a battery to keep those in operation working at nearly full load at all times.

Representatives: H. Himelblau; T. Agazim.

The Linde Air Products Co.,
30 E. 42nd St., New York, N. Y.
Booths 315, 316

This and associated companies will have an exhibit including a complete line of equipment and supplies for oxy-acetylene welding and cutting. Oxweld blowpipes, Prest-O-Weld machinery, carbic generators for oxy-acetylene welding and cutting and carbic flood lights will be featured. Interesting and instructive examples of welding used in power plant work will be displayed and the method of using the



system for installation and repair will be fully explained.

Representatives: E. J. Hayden; C. E. Ziesel; F. G. Outcalt; J. W. Haygood; L. M. Rasmussen; W. C. Harrison; A. G. Wikoff; R. W. Boggs.

Lovejoy Tool Works, Booth 230
319 W. Ohio St., Chicago, Ill.

This company will display its L-R flexible couplings, drill sleeves and other tools. The special feature will be the L-R flexible coupling to take care of angular misalignment up to 7½ deg., lateral misalignment to 3/16 in. and end play up to ¾ in.

Representatives: W. H. Dangel, president; W. A. Bickel, sales manager.

The Marley Co., Booth 54
1737 Walnut St., Kansas City, Mo.

Three feature products will be shown here including Marley spray cooling equipment, steam superheaters, and steam purifier. Marley superheaters are made for return tubular boilers with features designed particularly for this adaptation; steam purifiers are available for all standard sizes of boilers, the purifier being located outside the boiler.

Representatives: L. T. Mart, Kansas City; W. E. Rolston, Chicago manager.

Jas. P. Marsh & Co., Booths 422, 423
2073 Southport Ave., Chicago, Ill.

Marsh steam specialties will be shown here including the Hi-Lo vacuum and vapor heating systems, radiator traps and valves, boiler return traps, automatic air valves, air eliminating devices, the Marsh Merkustat electrical control instruments for pressure, temperature and water levels, industrial instruments including indicating and recording gages, vacuum gages, engine room clocks, revolution counters, gage board outfits, pop safety and relief valves. Of special nterest will be working models showing an actual Marsh Hi-Lo heating system in miniature to demonstrate the simple operation and perfect control.

Representative: A. D. Rose.

Mechanical Manufacturing Co.,
Booths 428, 429
Union Stock Yards, Chicago, Ill.

In this space the Thermal Unit Co., a subsidiary of the Mechanical Mfg. Co. will show Thermal unit heaters for heating and cooling, blast coils and concealed radiation. A special feature of the display will be two units sending out warm air and a third used to throw 32-deg. air into the room.

Representatives: T. W. Carraway; E. N. Murphy; A. H. Shipway; R. O. Zobel.

Merrick Scale Mfg Co., Booths 307, 308
Passaic, N. J.

Here will be exhibited the Merrick conveyor Weightometer in actual operation, weighing material in transit over a conveyor. Also will be shown the Merrick Addoweight, weighing buckets of coal passing over a monorail track and the mechanical Weighman for weighing boiler feedwater.

Representatives: F. P. Hambright, sales manager; T. F. Corpron, sales engineer.

Meyer-Ekstrom Co., Booths 212-3
11 South Desplaines St., Chicago, Ill.

Strong steam specialties, particularly the two new series of steam traps as manufactured by Strong, Carlisle & Hammond Co. of Cleveland, Ohio, will be exhibited here. There will also be shown Carling turbines and blowers, manufactured by the Carling Turbine Blower Co. of Worcester, Mass., and Q-P packing manufacturing by the Q-P Signal Co., Needham Heights, Mass.

Representatives: J. F. Meyer; G. Ekstrom; P. C. Weicker.

Midwest Air Filters, Inc., Booths 433, 434
Bradford, Pa.

Midwest filters for building ventilation, compressors, central stations, Diesel engines and chemical processes will be featured in this booth. Of special interest will be the models SH and SV which are automatic self-cleaning air filters with sinuous controlled air flow filter medium.

Representatives: A. E. Nealy, advertising manager; C. F. Larson; H. W. Pound; E. Ohnell, Jr.

Minneapolis-Honeywell Regulator Co.,
Minneapolis, Minn. Booth 450

This display will include equipment for heating systems including low pressure and high pressure valves for hand and motor operation in sizes from 2½ to 6 inches, gas and oil valves, relays and pressure control, protective devices, thermostats and similar apparatus.

Representatives: M. C. Honeywell, president, in charge; Ralph Goetzenberger; P. F. Shivers.

Modern Coal Burner Co., Booths 128, 129
307 N. Michigan Ave., Chicago, Ill.

This company will display one of its modern coal burners, which is of the underfeed stoker type with screw feeder, driven by electric motor. It is designed especially for the handling of low grade coals such as screenings of the Illinois and Indiana products.

Representatives: H. W. Burnham, vice president; Arnold Lindeman; V. G. Leach.

Modine Manufacturing Co.,
Racine, Wis. Booths 141, 142

Here will be found Modine unit heaters for industrial heating and drying, cabinet and recessed heaters for commercial and domestic radiation, with working exhibit of unit heaters as a special feature of the display.

Representatives: C. J. Rice, sales manager heating division; O. E. Desmond, advertising manager.

Murray Iron Works Co., Booth 116
Burlington, Iowa.

A two-stage steam turbine with upper half of the casing removed and a model boiler will be displayed and, as special features, improvements will be demonstrated in the design of Murray-Standard turbine and of the Murray Iron Works Co.'s boilers. The turbine is axial-flow impulse type with one or more two-row velocity stages followed by a number of single row pressure stages. Demonstration will be made of the special nozzle arrangement for changing from one load to another by adjustment of four valves.

Representative: J. Y. Dahlstrand, manager turbine department.

Nash Engineering Co., Booths 76-79
So. Norwalk, Conn.

Vacuum and condensate pumps for removing gases, air and condensate from heating systems, of Jennings-Hytor type, will be shown here; also circulating pumps for hot water condensing systems and fluid ejection.

Representatives: J. M. Stannard; G. W. Clucas; R. L. Sutherland; H. C. Crane.

National Air Filter Co., Booths 425, 426
5130 Ravenswood Ave., Chicago, Ill.

Filters, dust arresters, and pressure indicators and regulators will make up the display in this space. The different types to be shown will be the Airmat in cabinet and pocket type, the TooPas, Simplex, Phoenix and Rotary air filters; also a cartridge compressor filter and the National pressure indicator and pressure regulator.

Representatives: J. L. Harpham, sales manager; H. E. Birkholz; R. G. Birkholz; W. G. Frank; Q. G. Ewen, Chicago; W. C. Kruse, New York.

National Aluminate Corp., Booth 60
6216 W. 66th Place, Chicago, Ill.

Use of KWS sodium aluminate for scale reduction and removal will be demonstrated in this space, the details of this system of water treatment for external and internal treating for steam plants and for distilled or raw water ice plants, being fully explained.

National Power Construction Co.,
Fisher Building, Chicago. Booth 151

Pictures of settings installed by this company at various power plants will make up the exhibit in this booth showing foundation and boiler setting work and other features of power plant construction.

Representatives: A. L. Scheying; Glenn E. Reynolds.

the Nicholson weight-operated trap and sectioned models of each type. Nicholson flexible coupling will be demonstrated by a motor-driven running model showing the adaptability to misaligned shafts.

Representatives: H. S. Nicholson, manager; R. A. Comstock, sales engineer.

Norma-Hoffman Bearings Corp.,
Stamford, Conn. Booths 33, 34

Norma-Hoffman ball, roller and thrust bearings will be displayed here, also the latest design of Hirth Minimeter for measuring duplicate parts accurately to fractions of a tenth of a thousandth of an inch. Typical mountings of bearings on motors, reduction gears and the like, will be shown, properly sectioned to illustrate the method of mounting.

Representatives: O. P. Wilson, vice president; Norman Bell, assistant secretary; G. R. Bott, engineering manager; D. E. Batesole, assistant engineering manager; T. J. Harley, Chicago district

Pacific Electric Mfg. Corp. Booth 189
5815 Third St., San Francisco, Calif.

Products to be found in this exhibit will include a 50,000-volt oil circuit breaker, outdoor type, with motor-wound spring operated mechanism set up for electrical operation; a 15,000-volt oil circuit breaker, outdoor type, with motor-wound spring operator; 50,000-volt, single-pole unit, Type TX disconnecting switch for gang operation; 50,000-volt single-pole disconnecting switch, Type S, for similar operation. Special features of interest will be the rotary, horizontal break principle of oil circuit breaker construction employing six breaks per phase with wound-type current transformers in tanks of the breaker and motor-wound, spring-actuated control mechanism for control and economical application to auxiliary control.

Representatives: G. B. Kirkwood, Chicago district manager; J. T. Cavalier, St. Louis; A. A. Marrs, Kansas City, Mo.

National Safety Council, Booth 338
108 E. Ohio St., Chicago, Ill.

This is a non-commercial coöperative association for promoting safety in all kinds of industrial plants, in the home and on the street. It will display the outstanding features of a highly specialized and comprehensive accident prevention service with a special feature of an automatic moving display of industrial safety posters under flood light arrangement and samples of all Council publications designed to help employers interest their workers in safety and to interpret safety to the workers.

Representatives: W. L. Wheeler, business manager; P. N. Bushnell, director service extension; R. C. Kleinow.

The Herman Nelson Corp.,
Moline Ill. Booths 415, 416

Products to be shown here will include the Herman Nelson hiJet heater for industrial and commercial buildings, Univent ventilator for schools, offices and similar buildings, Herman Nelson invisible radiator for building into walls and partitions in homes, offices and buildings where old style radiation is undesirable.

Representative: J. M. Robb, in charge.

The New Departure Manufacturing Co.,
Bristol, Conn. Booth 9

Exhibited in this space will be New Departure ball bearings in all types and for all uses. A special feature will be a ball bouncing exhibit and the application of ball bearings to machine tools.

Representative: George W. Fowler.

W. H. Nicholson & Co., Booths 144-148
Wilkes-Barre, Pa.

This exhibit will be found in the space of the Ernest E. Lee Co. and will include an actual working model of the Nicholson piston-operated trap of latest Model B type with glass sides, showing clearly the operation and discharging capacity of the equipment. The company will also show a similar model of

manager; T. M. Kaino, C. D. Kilham, district representatives.

Northern Equipment Co., Booth 134
Erie, Pa.

In this booth the company will exhibit the Copes System of boiler feed control with a working model of the Copes feedwater regulator in actual size cut away to show the operation of the control valve. Also will be found the new type RG combined feed flow water pressure regulating valve and the type SS differential water pressure regulating valve. Other features in the exhibit will be the new Copes type DS pump governor and the Standard Copes governor with orifice type condensate discharge valve and the Tripper type thermostat.

Representatives: E. W. Nick, president; V. V. Veenschoten; C. E. Wolff, Jr., in charge.

Wm. W. Nugent & Co., Inc., Booth 82
410 N. Hermitage Ave., Chicago, Ill.

Oil filters, pumps, tanks, oiling and filtering systems, oiling devices, sight feed valves, compression union fittings and other similar equipment will be displayed in this booth. Particularly featured will be the complete oiling and filtering systems and telescopic oilers for crossheads and crankheads.

Representatives: C. D. Nugent; J. Vocelka.

The S. Obermayer Co., Booths 456-458
2563 W. 18th St., Chicago, Ill.

Products to be found in this exhibit will include Ramtite plastic monolithic furnace lining, Esso No. 300 carborundum furnace lining, Esso Bonds Nos. 40, 35 and 32, Obermayer Hott Patch No. 31 and Esso refractory gun. As a special feature will be a demonstration of the adaptability of Ramtite to various purposes and of the Esso refractory gun in operation.

Representatives: Theo. Kauffman, Jr., manager refractory division; George F. Doyle; R. S. Higgins; E. D. Frohman.

Paige & Jones Chemical Co., Inc.,
Hammond, Ind. Booth 46

This company's exhibit will consist principally of an exact model of a 100,000-gal. zeolite water softener and will have as a special feature the company's new electric proportioner solenoid control for lime-soda ash softeners. This feeding device for lime-soda ash is new and will be found of special interest.

Representatives: Fred O. Paige, Jr., secretary and general manager; C. L. Sidle, general sales manager.

The Parker Appliance Co. Booth 420
10320 Berea Rd., Cleveland, Ohio.

This company will display in its booth a complete line of Parker tube couplings in standard, extra heavy and double extra heavy brass, in nickel alloy and steel, also copper and steel tube for power plant installations. A special feature will be a line of tube bending and fabricating equipment with flaring tools and all items required for the installation of Parker copper plumbing in power plant and other layouts. There will also be a flow meter and draft meter with complete copper tube connections including a manifold for draftmeters with complete valve assemblies. Representatives will be prepared to bend and demonstrate the use of the bending and fabricating equipment.

Representatives: C. E. Klamm, in charge; W. R. Rapprich; W. C. Brown; A. L. Parker.

Pennsylvania Crusher Co. Booth 8
Liberty Trust Bldg., Philadelphia, Pa.

Working model will be shown of Bradford coal breaker and cleaner, also of Armorframe single row crusher and of Steelbuilt coal preparation machinery

Representative: Stanley B. Hawthorne.

The Permutit Co. Booth 222
440 Fourth Ave., New York, N. Y.

The principal and most interesting exhibit of this company will be a model of

water softening and filtering equipment as used in industrial plants. This will be 4 ft. long, made exactly to scale after the design of a large commercial unit that delivers 100,000 gal. per day, the small pipes and strainers in the interior of the water softening tank being reproduced in miniature. The model will represent a striking and clever piece of workmanship. It will illustrate the practice of the company in small as well as large plants for treatment of water for power plants and industrial purposes. Other features of the exhibit will be Ranarex instruments for recording carbon dioxide, gas density, ammonia gas, and the like, operating upon a purely mechanical principle.

Representatives: F. S. Dunham; H. P. Sherwood; I. J. Bready; R. S. Ellis, Chicago; H. J. Keays, Milwaukee; N. D. Doane, Indianapolis.

Plibrico Jointless Firebrick Co. Booths 130-132
1800 Kingsbury St., Chicago, Ill.

Here will be found a miniature picture theatre showing continuously the movie, Fighting Furnace Failures. Also will be shown a built up wall to illustrate the method of installation of Plibrico and the Plibrico exclusive flexoanchor. A section of water wall will be exhibited showing the use of Plibrico to this type of wall.

Representative: I. S. Pieters, vice president.

William A. Pope, Booth 81
26 N. Jefferson St., Chicago, Ill.

This space will be used as a meeting place for the friends of Mr. Pope and his organization to discuss methods of modern piping installation and to explain the work which they have done in installing and remodeling large plants.

Representatives: R. A. Widdicombe; Austin Pope; William H. Miller.

The Powers Regulator Co. Booth 455
2720 Greenview Ave., Chicago, Ill.

Systems of temperature and humidity control for offices, workrooms and process rooms will be exhibited and demonstrated. Regulators to control the temperature of liquids, gases and air in industrial processes will also be shown and thermostatic regulators to control the mixing of hot and cold air, hot and cold water, steam and cold water, to deliver a mixture at any temperature desired. Other features will be high-pressure steam traps and dial indicating thermometers.

Representatives: A. E. Schad, sales manager, in charge; W. P. McFarland; E. W. Rietz; Ralph Kimble; Hal Mueller; T. J. Smith.

Power Plant Specialty Co., Booth 38
440 S. Dearborn St., Chicago, Ill.

Here will be found a small size chemical proportioner for the company's water softener system and, as a special feature, large size mounted blue prints of the company's apparatus and photographs of the company's installations. On account of the large size of the actual apparatus, it is impracticable to exhibit a complete plant.

Representatives: W. H. Stevenson, president; M. B. Peirson, secretary; N. W. Hobson.

Power Transmission Association
Drexel Bldg., Philadelphia, Pa. Booth 337

This exhibit will consist of educational data of interest to users of power transmission equipment, special features being diagrammatic drawings showing the economies and savings effected by using the proper drive for each installation.

Representative: W. S. Hays, executive secretary.

Prat-Daniel Corp., Booth 150
183 Madison Ave., New York, N. Y.

Thermix products will make up the exhibit in this space. There will be included type 4, dust-eliminating induced draft fans which will be a special feature arranged in actual operation so that collections of powdered fuel dust can be shown and other products tested for collection. Also there will be type 1 combined stack and induced draft fan in which the fan handles all of the gas; type 3 combined stack and induced draft fan using the ejector system where only part of the gas is handled by the fan; the Thermix air preheater and the soot blower for the air preheater. Operation of all apparatus will be fully explained.

Representatives: H. L. Parry; H. E. Wheeler.

Ramsey Chain Co., Inc., Booth 84
Albany, N. Y.

Here will be shown silent chain drives, sample pinions, sprockets and chains. A special feature will be a typical 1½-in. pitch Ramsey silent chain drive mounted on a frame and operating at full speed to demonstrate the smooth, quiet operation of these drives. Details of the construction of the compensating joint in the chain will be shown and also as another feature the Elgin tachometer, used to demonstrate the absence of friction in the joints of the chain.

Representatives: D. I. Wheeler, sales manager; Daniel Kessler, Chicago branch manager; E. J. Smith, sales engineer, Chicago; H. N. Davis, Cleveland branch manager.

The Rawlplug Co., Inc. Booth 219
66 W. Broadway, New York, N. Y.

Rawlplugs, which are screw anchors of jute fibre for anchoring screws in masonry and requiring a hole scarcely larger than the screw itself, will be displayed and demonstrated in this space and a demonstration made of the holding power of this device. In addition the Rawldrill, for fast cutting in masonry will be shown, illustrating the possibility of sharpening on the job by the man using it. A special feature will demonstrate the holding of the Rawlplug when subjected to sudden shock or severe strain.

Representative: H. G. Janton, exhibit manager.

Reed Air Filter Co., Booth 435
215 Central Ave., Louisville, Ky.

A complete line of Reed air filtering equipment will be shown here, featuring particularly the new Reed multi-panel automatic air filter which is causing great interest in the steel industry by application to mill motors and turbine-generators for ventilation.

Representatives: H. C. Murphy, vice president; J. R. McConnell, sales manager; J. H. Milliken, Chicago representative.

Reeves Pulley Co., Booth 139
Columbus, Ind.

Reeves variable speed transmissions in different designs will be shown in this exhibit, including a new design for electrical remote control, a design equipped with automatic control, completely enclosed design transmission and the Reeves transmission with motor base. All exhibits will be of improved type, having the double block V-belt, interlocking splice block, dial-type speed indicator, force feed lubrication, compact frame and other improvements to increase utility and efficiency.

Representatives: Carl M. Reeves, vice president; Paul B. Reeves, vice president; A. E. Shibley, manager Reeves-Bond Sales Co., Chicago; F. T. Moore, H. M. Glessner, Chicago office.

Reiter Co., Booth 36
Elgin, Ill.

This display, under the name of the Elgin-Reiter Co., will include the Elgin deconcentrator, zeolite water softener and corrosion products. Of special interest will be a small working model of the Elgin deconcentrating unit to demonstrate the principle and operating method of the equipment.

Representative: Lucius A. Fritze, director of sales.

Republic Flow Meters Co., Booths 66, 67
2240 Diversey Parkway, Chicago, Ill.

Products to be exhibited here will include steam meters, water meters, CO_2 recorders, gas meters, air meters, pyrometers and other equipment to constitute a complete line of industrial instruments.

Representatives: S. Vail, C. Parsons, G. Conlee, W. Eckdahl, C. Pride, Chicago; H. Skabo, Gary; J. Tigerman, Kansas City; C. Armstrong, St. Louis; M. Johnson, Milwaukee; K. Roudebush, Cincinnati.

Riley Stoker Corp., Booths 199-201

Here will be found the improved Riley Atrita unit pulverizer with capacity of 5,000 lb. of coal an hour, also the Riley Flare-Type burner. The pulverizer will be of the new box type construction recently developed. Other features of the exhibit will be a Jones stoker unit with complete side dump equipment and Riflex drive having the unit band located just in front of the drive.

Representatives: Robert J. Kruger, advertising manager, in charge; F. H. Daniels, James W. Armour, L. E. Griffith.

Sarco Company, Inc. Booth 26
183 Madison Ave., New York.

This company will show various types of steam traps for the industrial field, standard and special temperature regulators for hot water service tanks, industrial processing and drying kilns. Also will be shown a special line of regulators for refrigeration work suitable for temperatures from 0 deg. F. up. As a special feature will be found the complete Sarco heating line, including inlet valves, thermostatic traps and other apparatus required for low-pressure vacuum and vapor heating systems.

Representatives: G. H. Burke, E. J. Ritchie, O. G. Jenner, H. C. Schilling, L. Barful.

Sauerman Bros., Booths 18, 19
438 S. Clinton St., Chicago, Ill.

This exhibit will deal entirely with the Sauerman power drag scraper systems for storing and reclaiming coal and other bulk materials. An outstanding feature of the display will be a working model showing complete Sauerman power drag scraper installation handling coal into and out of a storage on the ground alongside a power plant. The model will be shown in operation, demonstrating exactly the method of action and the advantages.

Representatives: D. D. Guilfoil, J. L. Nellis, F. A. Pement, J. A. Schultz.

Schade Valve Manufacturing Co., Booth 64
2527 N. Bodine St., Philadelphia, Pa.

This company will exhibit in the space

of Himelblau, Agazim & Co., its Chicago representatives.

Shell Petroleum Corp., Booth 306
Shell Bldg., St. Louis, Mo.

Shell industrial oils will be displayed here and the system of the Shell lubricating surveys of plants to increase lubrication efficiency will be explained and demonstrated.

Shepard Electric Crane & Hoist Co.
Montour Falls, N. Y. Booth 300

Two of the company's new compact hoists will be shown in operation, also a display of photographic enlargements illustrating installations of the company's complete line of hoisting equipment in capacities from ¼ t. to 30 t.

Representatives: R. T. Turner, sales manager, W. B. Briggs, G. G. Robbins, H. A. Baugh.

D. H. Skeen & Co.,
Booths 71-74, 75-98, 100-102
Monadnock Block, Chicago, Ill.

As manufacturers' representatives, this company will have a varied display as follows: Ljungstrom preheaters of the Air Preheater Corp. in booth 99; arch and side walls of the American Arch Co. in booth 102; ash-sluicing equipment of Allen-Sherman-Hoff in booths 71, 72; Apexior protective coatings of the Dampney Co. in booth 100; dust collectors of the Dust Recovery Co. in booth 73; deconcentrators of the Henszey De-Concentrator Co. in booth 74; pressure regulators of the Mercon Regulator Co. in booth 74; water column illuminators of the National Co. in booth 101; water level controllers of Stets Co. in booth 101; power plant equipment of D. H. Skeen & Co. in booths 75-98.

Representative: M. G. Hughes.

Springfield Boiler Co., Booth 208
Springfield, Ill.

In this booth will be found various parts of the Springfield water-tube boiler and also of the Springfield all-steel sectional water wall, to illustrate construction and the advantages of design of the various parts. These will further be illustrated by blue prints, photostats and pictures of recent and modern installations of boilers and water walls.

Representatives: Owsley Brown, president; J. S. Hammerslough, vice-president; Hans J. E. Banck, chief engineer; O. J. Gasche, Benjamin Hart, Chicago representatives.

Standard Oil Co., Booth 37
910 S. Michigan Ave., Chicago, Ill.

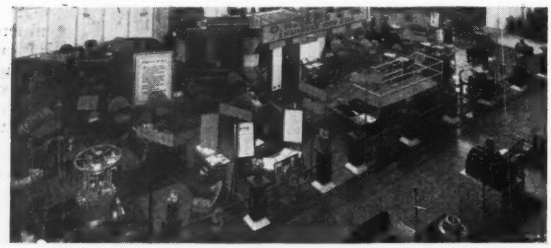
Lubricants for use on every type of equipment used in power plants will be included in this exhibit. Display will show the exterior and interior of the power plant, with lighting effect so arranged that different units of the plant will light up alternately, showing the different equipment and the proper grade of lubricants for correctly lubricating that particular equipment.

Representative: R. E. Vogel, in charge.

Stephens-Adamson Mfg. Co., Booth 171
Aurora, Ill.

Several types of JFS variable speed transmissions are to be shown; also some of the latest developments in anti-friction belt conveyor carriers. Two operating models of the JFS speed changer will be displayed, both being driven by standard constant speed electric motors and with instruments to show the small variation of speed at which power can be delivered by these machines. One of the belt conveyor carriers is the new No. 455 which has double ball bearings and three-pulley carrier, designed with new style roller supports which afford protection for the bearings. Another interesting feature will be the details of the new S-A Silo System for live and dead storage of coal in small and medium sized plants.

Representatives: C. H. Adamson, secretary; E. J. Patton, advertising manager; J. R. Bold; R. S. Jacobsen; F. W. Kenzler; L. V. Lindquist J. A. H. Phillips; T. A. Ruddy; P. C. Smith.



Sterling Engineering Co., Booth 143
1626 Holton St., Milwaukee, Wis.

Products found in this booth will include the Sterlco thermostatic trap and Vacu float vent for vapor heating, graduated packless valves, air eliminator, vacuum air vent, return trap and unit heater trap. Specially featured will be the Sterlco steel sectional gas fired boiler which will generate steam for exhibit of the Modine Mfg. Co., makers of unit heaters and copper radiation.

Representatives: George W. Anders, president; Faber O'Hagan, Chicago.

Stets Co., Booth 101
141 Milk St., Boston, Mass.

This company will exhibit its Type E controller in stainless steel construction for the control of water level in boilers. This is a new construction, designed for high pressures and with all moving parts enclosed. In addition there will be displayed the company's new line of forged steel gage valves and stainless steel trycocks for wrought steel, high and low alarm water columns, built for pressures up to 900 lb. and above.

Representatives: J. H. Randall; George W. Stetson; D. H. Skeen.

Stockham Pipe & Fittings Co., Booth 111
Birmingham, Ala.

This company's line of cast steel fittings used for high temperatures or high pressures or both, will make up the main part of the exhibit, although the company manufactures also cast iron and malleable iron fittings. There will be found, however, in the booth a line of malleable fittings that has been developed during the past year for higher pressures often used in oil company work and known as heavy oil malleables, oil malleables and hydraulic malleables. A notable feature of the display will be a spectacular fitting made especially for the Gorgas Plant of the Alabama Power Co. of cast steel. It is a 12 by 14 in. tee with side outlet for 600 lb. working steam pressure and has a total weight of about 1600 lb.

Representatives: Douglass W. Stockham; Roy L. Stewart; Harry N. Hall, advertising manager; Germer Petesch; Allen Clark.

Strom Bearings Co., Booth 23
4527 Palmer St., Chicago, Ill.

Ball bearings will make up the exhibit in this space, including single and double row for radial work, single and double row angular contact, also thrust bearings and adapter type bearings of the Strom and Super-Strom types.

Representatives: M. E. Monk, director of sales; H. N. Parsons, chief engineer; E. H. Rahn, E. P. Schmidt, H. R. Higgins, sales engineers; L. Anderson, service engineer; Charles Nelson, chief draftsman.

The Strong-Scott Mfg. Co., Booth 185
413 South Third St., Minneapolis, Minn.

Here will be exhibited a working model and framed photographs of the Unipulvo system for coal pulverizing and burning showing the special features of the system and of the equipment, also the advantages of this installation, for pulverized coal plants.

Representatives: Homer L. Rank, Unipulvo sales manager; George W. Heald; Henry G. Lykken; Albert W. Strong; Roy K. Culbertson.

Sumet Corp., Booth 20
1543 Fillmore Ave., Buffalo, N. Y.

Finished bars and castings, bronze drawn rods in various diameters and lengths, all made by the Sumet process, will be shown in this display. This process distributes lead evenly through a matrix of copper which supports it, thus giving a bearing with the strength of bronze and the anti-friction qualities of lead. As a special feature will be shown a medium speed motor with Sumet bearing on the shaft and load applied to bring the bearing temperature to 800 deg. F., to demonstrate under what extreme conditions the metal will operate.

Representatives: H. O. Warner, sales manager; H. D. Mitchell, chief engineer.

The Superheater Co., Booths 124, 125
17 East 42nd St., New York, N. Y.

This exhibit will consist primarily of a pictorial display of the multiple loop,

single-pass superheater, an exclusive Elesco development. These are of the basic Elesco design as applied to all makes and types of boilers and accompanying panels will enumerate the advantages inherent to the arrangement.

Representatives: R. M. Gates, manager industrial division; W. H. Armacost; V. W. Smith; A. H. Chas. Dalley; R. S. Cooper.

The Swartwout Co., Booths 50, 51
Cleveland, Ohio.

This company will exhibit its line of feedwater regulators, pump governors, master controls, special regulating and reducing valves, steam, oil and air separators, exhaust heads, high and low pressure and boiler return traps, feedwater heaters, rotary ball bearing roof ventilators and desuperheater governors.

Representatives: D. K. Swartwout, Jr., vice president and general manager; E. H. Bolton; Geo. S. Montgomery; L. V. Warner; L. P. Russon.

The Texas Co., Booth 432
332 S. Michigan Ave., Chicago, Ill.

Lubricating oils and greases will make up the display in this space, interesting demonstration being given of the methods of manufacture, the adaptability of various lubricants for different purposes and the qualities of the various products of the company.

Representatives: N. H. Steindler, H. E. Delcour; A. J. Herom.

Timken Roller Bearing Co.,
Canton, Ohio. Booths 413, 414

Here will be found a mechanical display portraying the wide use of Timken bearings in industrial and automotive equipment. A bearing of the type used on steel mill rolls and a complete railway bearing and mounting will also be shown, the latter being cut away to show details of construction.

Representatives: L. M. Klinedinst; G. D. Thewlis; R. P. Proffitt; R. W. Ballentine; G. W. Curtis; R. P. Kelley.

The Uehling Instrument Co.,
Booth 149
473 Getty Ave., Paterson, N. J.

Special display will be made of the new electrically operated Apex CO_2 recorder and indicator which has no steam, water, drain or exhaust lines and will record percentage of CO_2 within ¼ of one per cent. Another feature of the display will be the Uehling combined barometer and vacuum recorder giving two records on the same chart so that, using the barometric record as base line, absolute pressure can be read directly without calculation. The instrument uses the mercury column principle without springs, diaphragms, or multiplying levers.

Representatives: C. J. Schmid, F. D. Bogia, P. J. Riccobene, Paterson, N. J.; Ernest E. Lee Co.

The Unishear Co., Inc., Booth 412
270 Lafayette St., New York, N. Y.

A complete line of Unishear will be displayed in this space, featuring model A-10 especially. The Unishear is a machine for quick cutting of sheet metals of every description to any shape. It is made as a motor driven portable hand shear and in various sizes of stationary types for permanent shop installation.

Representatives: H. J. Heller, vice president; George B. Shiras, sales manager; Max Carsen, Chicago representative in charge.

The Vulcan Soot Cleaner Co.,
DuBois, Pa. Booth 160

This company will show a self-contained monel-trimmed Vulcan operating head; also a ratchet operating head and Crodon corrosion-resisting blower element. Detail parts of the blowers will also be exhibited.

Representatives: D. E. Hibner, Jr.; C. L. Burnham, Mr. LeVally, Chicago office.

Walworth Co., Booth 449
Statler Bldg., Boston, Mass.

Included in this display will be the company's tool line, including the Walworth master Stillson wrench, Parmalee wrench, Walworth dies, roller pipe cutter and three-wheel pipe cutter. A special feature will be tests of the master Stillson made to demonstrate its strength on a device which throws a load of 1800 lb. on the end of a 14-in. wrench handle.

Representatives: Henry Lambert, New York office; L. P. DeGroot.

Weber Insulations, Inc. Booth 234
East Chicago, Ind.

Products to be displayed in this space will include Weber's special insulating cement, shrinkless insulating brick, insulating block, Lavafelt quilt and pipe covering.

Representatives: Louis Weber, president; Louis Weber, Jr., superintendent; Fred Elizer, sales manager; William Weber, manager.

Warren Webster & Co., Booths 41, 42
Camden, N. J.

The new Webster Moderator system of steam heating will be shown and especially featured, this being an entirely new development in steam heating. Other equipment for heating systems will also be displayed and fully explained.

Representatives:

Westco-Chippewa Pump Co.,
Davenport, Iowa. Booths 412-427

Display of the company's pumps will demonstrate the one-moving part construction. Results of efficiency tests will be exhibited and the means by which they are attained will be explained.

Westinghouse Electric & Manufacturing Co., Booths 121, 122, 162, 163
East Pittsburgh, Pa.

Featured in the exhibit of this company will be the retort of a multiple retort stoker; a 10-kw. and 3-kw. turbine generator set; a mechanical drive turbine of Type 2-AMP; a tap changer; lightning arresters; network protector and Micarta specialties.

Representatives: J. W. Robinson, H. T. Francis, T. W. Merrill, E. H. Ott, R. B. Brennan, Byron Hill, W. J. Healey.

The D. E. Whiton Machine Co.
New London, Conn. Booths 144-148

This exhibit will be in the space of Ernest E. Lee Co., and will include the Whiton steam turbine type BB with cover opened to show rotor and nozzles. It will be equipped with built-in excess pressure governor as supplied for boiler feed pump driving and with a special no-water stop to shut down the pumping unit should the suction line fail. Another feature will be a separate shaft packing of the company's bronze alloy labyrinth ejector type.

Representatives: Ernest E. Lee; C. M. Hardin; J. L. Higgins; M. T. Jansen, Lucius E. Whiton; J. H. Leatherbee.

W. P. Whittington, Inc., Booth 10
Indianapolis, Ind.

This company will exhibit its new vacuum heating pump of the horizontally-split, centrifugal type having automatic float and vacuum switches and automatic starters.

Representative: C. B. Adams, Chicago representative.

The Wickes Boiler Co., Booth 166
Saginaw, Mich.

A lantern slide machine will be used here to show methods of manufacture, drawings of product and plans and photographs of installations of the Wickes Boiler. Especially featured will be models and riveted sections showing the details of the boiler design and construction.

Representatives: C. F. Wilson; M. S. Nelson.

L. J. Wing Mfg. Co., Booth 424
154 W. 14th St., New York, N. Y.

Forced draft and centrifugal blowers, unit heaters, exhausters and fans will make up this exhibit. The forced draft blowers are of turbine and motor-driven type for supplying forced draft to stokered and hand-fired boilers. Turbine-driven blowers are installed directly in the boiler wall and deliver individual draft to each boiler. Motor-driven blowers are especially for low-pressure heating boilers. Centrifugal blowers are for supplying air under higher pressures than those given by the propeller type, for use in connection with gas producers, lumber kilns, pulverized coal burning and the like. Unit heaters are the Wing featherweight for heating factories and industrial plants and a miniature heater will be shown in action, operating in a background of an actual illustration of an industrial plant. In the Scruplex exhauster, the motor which drives the fan is removed from the stream of air, vapors or fumes so as to be entirely protected, while the Scruplex fan has cast aluminum blades for quick and effective operation.

Representatives: H. S. Wheller, vice president; V. H. Carples, secretary and treasurer; C. W. Diemecke, Chicago representative.

Wright-Austin Co., Booth 87
315 W. Woodbridge St., Detroit, Mich.

Products on display here will be the company's regular line of steam and oil separators, water columns and steam traps with special emphasis placed on the new Airxpel steam trap, the Kleervu gage glass protector and the Crescent try cock which have been developed within the last two years.

Representatives: C. B. Walter, president; H. R. Patterson, manager Chicago office, in charge.

Yarnall-Waring Co. Booths 24, 25
Chestnut Hill, Philadelphia, Pa.

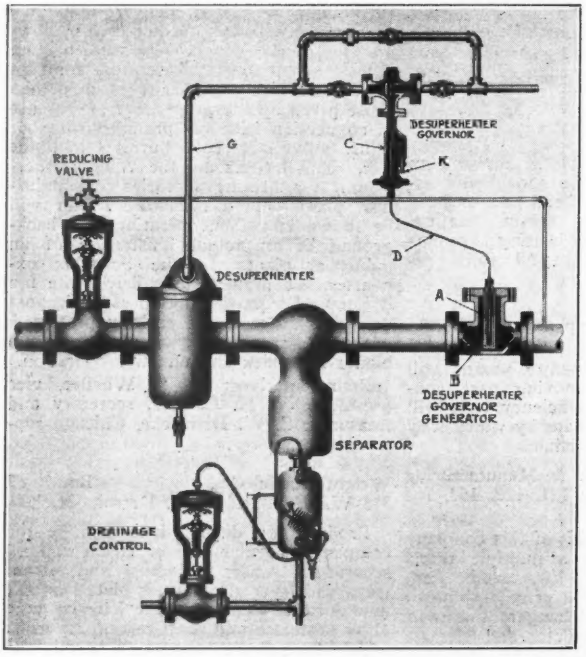
Yarway blowoff valves for working steam pressures up to 1400 lb. will be shown in a complete line, also a sectioned working model of the Yarway seatless blowoff valve, showing internal parts and method of operation. Other features to be shown will be types of Yarway floatless Hi-Lo alarm water column with Sesure inclined gages for pressures of 250-400 and of 600 lb. The displacement principle of operation of these water columns, where solid weights are used instead of floats, will be clearly demonstrated by cut-away model and a separate group of internal parts, arranged as used in actual service.

Representatives: H. J. Moyer, district manager; A. L. Aicher, service engineer.

Power Plant Engineering Developments and News

Swartwout Desuperheater Governor

DESUPERHEATERS for steam ordinarily employ water to remove the superheat; in such cases the maintenance of proper temperature of steam leaving the device depends upon control of the amount of water



GENERATOR A ACTUATES GOVERNOR C TO CONTROL WATER TO DESUPERHEATER

admitted to the desuperheater. To provide an accurate and automatic control for this water, The Swartwout Co., Cleveland, Ohio, has recently developed a desuperheater governor as shown. It is designed so that it will not be affected by wide fluctuations in load and so that any desired degree of superheat may be left in the steam, or none at all, if desired.

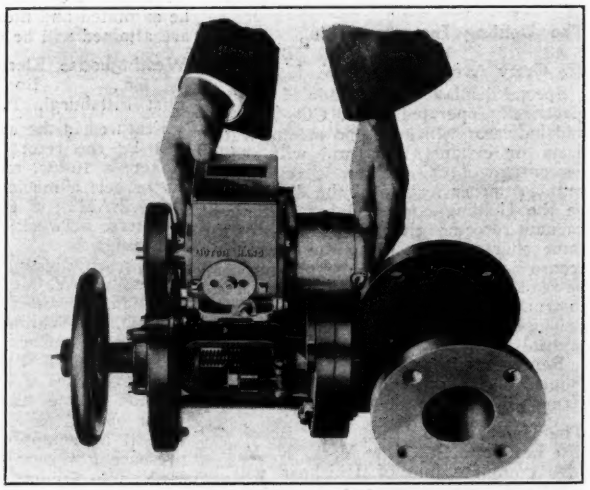
This governor is actuated by a generator in the steam line leaving the desuperheater. In this generator A, which is filled with water, the steam passing around the well B heats the water in the generator up to the temperature of the surrounding steam and evaporates some of the water. This creates a pressure equal to the saturated steam pressure corresponding to the temperature of the steam leaving the desuperheater. In turn, this water pressure acts on the underside of the diaphragm of the governor valve C, this diaphragm working against a spring.

If the steam leaving the desuperheater is saturated, pressure generated by A will be the same as that of the saturated steam, therefore pressures on both sides of the diaphragm are equal, since the top side is at the same pressure as the interior of the desuperheater. Now, if the temperature of the steam leaving the desuperheater rises, pressure in A is correspondingly increased, which acts on the lower side of the diaphragm to open valve C, admitting more water to the desuperheater to remove the superheat.

A screw adjustment, K, is provided for varying the tension of the spring in the governor so that any desired amount of superheat can be obtained in the outlet line.

Motor-Driven Mechanism for Operating Valves

FOR AUTOMATIC operation of all valves up to 6 in., a new motor-driven valve operating unit has just been announced by the Cutler-Hammer Mfg. Co., Mil-



MOTOR-DRIVEN MECHANISM FOR OPERATING VALVES UP TO 6 IN.

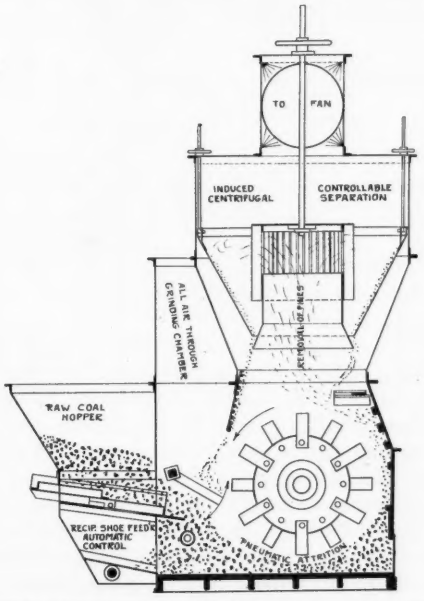
waukee, Wis. This operating unit has a rating of 15 lb. ft. It is designed to be operated automatically by means of float switches, temperature controlling devices, pressure regulators and the like or by conveniently located push buttons. It is similar in principle to the standard C-H "Dean" operating unit.

While designed primarily for valve operating service

in industries where regulation of pressures and temperatures of gases and fluids is necessary, it is likewise adaptable to many miscellaneous applications, such as operating skylights, awnings, radiators, garage doors.

Underfeed Unit Pulverizer

UNDERFEED UNIT pulverizers have been added to the Unipulvo line during the past year. The coal hopper supplied as part of the equipment is located in front of the rotor and close to the floor so that it can be readily supplied, by shoveling if desired. The feeder is of the reciprocating type, wide at the rotor chamber and from 24 to 30 in. long. The feed opening into the mill is the full width of the feeder and from 6 to 8 in. high. The rate of feed is controlled by the length of the stroke, which is adjustable either manually or automatically.



NEW UNDERFEED TYPE UNIPULVO, SHOWING FEEDING MECHANISM

Pulverizers of 2000 lb. per hr. capacity and over have the additional feature of automatic control. Located in the grinding chamber are oscillating "feeder bars," interlocked with the feeding mechanism in such a manner as to maintain any desired depth of coal in the chamber. As the coal tends to lower, the stroke of the feeder lengthens. As the level tends to rise, the stroke is shortened or stopped altogether, to prevent overfeeding or "slugging" of the mill.

Grinding principle of the Unipulvo Pulverizer is that the hammers act merely as fan blades, swinging clear of the coal and merely moving the air, which in turn moves the coal so that grinding will be due to a thin layer of coal, less than 0.1 in. in thickness, swept around by the air and against the bed of stationary coal.

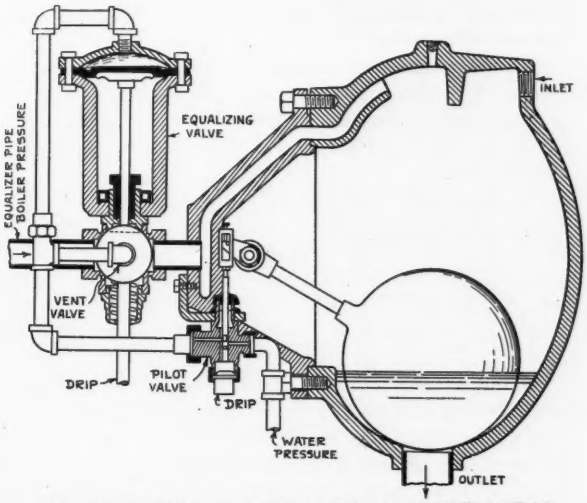
The coal goes around the rotor only once, thence into the separating chamber designed to throw out the oversize and return it to the grinding chamber, while the finished product goes to the fan and furnace with the air. It is intended that the fines shall be removed every time the material goes around the rotor.

In the separator is a disc having pendant vanes set tangentially to form a stationary whirler element that changes the vertical velocity to a vortex action. This is to cause the oversize to be thrown out by centrifugal action, which can be controlled at will to regulate the fineness.

As the hammers wear back, the grinding bed builds up automatically. The hammers are ordinarily used, it is stated, until at least 60 per cent of the original length is consumed without affecting the efficiency of the mill or the character of the product. The mill is built by The Strong-Scott Manufacturing Co., Minneapolis, Minn., in all capacities from 1000 lb. an hour to 10,000 lb. an hour.

Curtis Type T Return Trap

IN THE CURTIS Type T return trap, recently put on the market, the principal features are the stationary receiver, the accessibility of all moving parts and the packless gland on the float shaft. As shown in the sketch, the pilot valve is operated directly by the float, through the float shaft, while the steam or equalizing valve and the vent valve are operated by water or air pressure under the control of the pilot valve.



CROSS SECTION OF CURTIS TYPE T RETURN TRAP

When the latter is opened by the rising of the float, as the receiver fills with condensate, water pressure (or air pressure) is admitted to the diaphragm chamber of the equalizing valve. This opens the equalizing valve and closes the vent valve, these operations being properly synchronized. Steam then enters the receiver and condensate is discharged at the outlet. When the float reaches the bottom, the pilot valve closes, cutting off the pressure and allowing the equalizing valve to close and the vent valve to open.

This trap is designed so that only one valve adjustment need be made; namely, the adjustment for travel of the pilot valve in relation to the float. In the gland on the float shaft, sealing is effected by a collar on the shaft held against a composition washer by a spring at the other end of the shaft, thus obviating the necessity for stuffing box and packing. A gage glass is provided

to aid observation of the trap operation and to act as a telltale when adjusting float travel.

This Type T return trap is made in six sizes by Julian d'Este Co., Boston, Mass. These sizes range from the No. 0, rated at 1080 lb. of feedwater per hour, to the No. 5 rated at 16,800 lb. per hr., when used as boiler feeders. The trap is designed for high or low pressures and for use as a pumping or lifting trap with various liquids. When used thus, capacities range from 1860 to 28,000 lb. per hr.

New Approach to the Water Supply Problem

IN MANY PLANTS, the securing of an adequate and satisfactory water supply at a reasonable cost is one of the most difficult problems confronting the management. The lowering of the water table with attendant increased pumping costs, inadequacy of present wells, contamination of surface supplies, high cost of city water and similar factors all have a way of changing the supply problem in a few years. If the average industrial organization undertakes the development of its own supply, it often faces the possible loss of the investment in wells and equipment, where the wells do not measure up to the anticipated capacity, where the draw-down is beyond the limits of the well layout or where contamination makes the supply unsuitable for process purposes or human consumption.

Although enormous strides have been made in the design of efficient pumping equipment, there has not been as much progress made in the development of water supplies on a basis of a guaranteed supply at a definite cost.

An interesting step in this direction has, however, been made in the announcement of the organization of the Fairbanks, Morse Water Supply Co. The parent organization, Fairbanks, Morse & Co., has, of course, been a builder of pumps for many years. The new subsidiary organization, however, approaches the water supply problem from an entirely new angle.

After a thorough geological survey and hydraulic investigation of a plant's water supply has shown favorable possibilities, the Fairbanks, Morse Water Supply Co. agrees to deliver a definite quantity and quality of water at a definite price per thousand gallons. The plan is worked out so that the industrial organization is not required to invest any money in the pumping plant. Water is purchased at a fixed price for a period of years, at the end of which time complete title to the plant passes to the industrial organization. At any time during the period the purchaser has the option of taking over the plant.

In many cases, it is claimed, the fixed price for water is so much less than the cost of city water or so much less than a plant's former pumping costs, that the new plant is paid for out of savings. The industrial organization thus not only makes an actual saving but is relieved from all responsibility in the development of an assured water supply.

The Fairbanks, Morse Water Supply Co. is headed by P. D. Bowler as vice-president and general manager. Mr. Bowler is one of the founders of Layne & Bowler Corp. and was president and general manager of that organization for many years. The greatest assurance of success in the development of a water supply is in sound engineering and the Fairbanks, Morse Water Supply Co. believes that it has the engineering personnel, the organization and the financial resources for developing water systems on a guaranteed basis.

Several installations of this character are now being developed. The city of Havre, Montana, after several costly experiences with inadequate wells and after a number of costly plans had been outlined, turned its problem over to the Fairbanks, Morse Water Supply Co. As a result, a supply of 3 m. g. d. was guaranteed at an investment cost of $72,000 which is less than half the cost of the city's initial development supply of 1¼ m. g. d. Three plants are being developed for the city of Brooklyn, New York, which will be used for furnishing water for sluicing ashes at incinerator plants. At Muskegon Heights, Michigan, another guaranteed supply is being developed.

Power Conference and Engineering Congress

DETAILS of the programs are being worked out and related so that overlapping and interference will be avoided. The Engineering Congress will cover all branches, aeronautical, civil, electrical, management, marine, mechanical, mining, taking up technical practice, economics and details. The sectional meeting of the World Power Conference will devote special attention to the economic aspects of Development of Power Resources, matters of a purely technical nature being allocated to meetings of the Engineering Congress.

Divisions of the Conference program will be National and International Development of Power Resources; Unification and Administration of Electric Power Development; Future of Power Use in Transportation; Better Efficiency in Power Production; Distribution of Fuel and Power; Smoke Abatement in Cities. Meetings will be held in Tokyo, Japan, Oct. 30 to Nov. 7, morning and afternoon sessions being held.

Papers to be presented should be of not over 8000 words, with resumé of 500 words, typewritten, double-spaced and with a table of contents showing the important subjects treated. Papers may be in English, French or German but the resumé and table of contents should be in English. Maximum size for illustrations will be 4 by 7 in. Drawings should be jet black on white paper with block lettering of size twice that of the final cut and line proportionally heavy. Two copies of a paper should be in the hands of the secretaries by Apr. 1, 1929. Their address is Tokyo Sectional Meeting, World Power Conference, Nippon Doryoku Kyokai, Yuraku-kau Bldg., Maruno-uchi, Tokyo, Japan.

Excursions will be arranged for general sight seeing and engineering study. October 25 to 28 to Nikko and Hakoné for sight seeing and acquaintance. Nov. 2 to inspect reconstruction work of earthquake damage Nov. 3 to Kamakura for sight seeing. Short trips during the conference to schools, laboratories and engineering plants in and about Tokyo. Post-conference excursions of one to 12 days to visit mines, engineering plants and historic points in central and western Japan. The number on each excursion is limited so that early application is advisable. Correspondence should be addressed to the Secretaries at the address heretofore given.

R. M. Gates Elected to Vice-Presidency of The Superheater Co.

ROBERT M. GATES, well known as the Manager of the Industrial Department, has been elected Vice-President of The Superheater Co. Mr. Gates affiliated himself with that company in 1922 and has since been actively engaged in directing engineering and sales. He is a native of Iowa. Following his graduation from the School of Engineering, Purdue University, in 1907, he served as a special apprentice on the Pennsylvania Railroad and with The Browning Engineering Co. of Cleveland, Ohio, until 1910. The next few years he had his own engineering office in Cleveland and later was associated with The Thew Shovel Co., Lorain, Ohio, following which he was manager for the Lakewood Engineering Co. of Cleveland.

Mr. Gates has taken a prominent part in the activities of the American Society of Mechanical Engineers. For the past two years he has been Chairman of the Committee of Meetings and Program, and at the last general election he was made a member of the Council. The host of friends which he has made by his genial interest in engineering progress and his fellow men will rejoice with and congratulate him on this step forward in his career.

C. G. Y. King Speeded on World Tour by Friends at Banquet

ON THE EVE of his start, Jan. 12, for a trip around the world, Mr. King, formerly mechanical engineer and constructing engineer of the Chicago Edison Co., was tendered a dinner by some 200 of his associates.

During recent years much of his work in connection with large machinery orders has kept him in the east but those who remember the operation of the old Harrison Street station know well his notable achievements in the constructing of that station. As a feature of the evening, a model of that station was lighted up and placed in operation with smoke issuing from the stack as in the old days.

Son of a Scotch ship owner, Mr. King came to the United States in 1881, meeting Thomas A. Edison and Samuel Insull on the day of his arrival. In 1892 he came to Chicago as mechanical engineer of the Chicago Edison Co. and was identified with the construction of eight generating stations, some of which have now given way to modern progress.

At the dinner, Vice-president Louis A. Ferguson was the principal speaker and Chief Operating Engineer W. L. Abbott presided. Graphic account, with lantern slide illustrations and humorous comment was given by William A. Durgin of Mr. King's many sided activities. As evidence of these a few sample products were displayed including oil paintings, water colors on silk, ivory, wood and pipestone carving, ship models and curios.

Always fond of the sea, this hobby was emphasized by the wearing of Scotch and Admiral's hats by the guests, the use of ship's bells and the stentorian call of the bo's'ns mate for attention to features of the program.

All Mr. King's host of friends will join in wishing him fair winds, a following sea and a jolly trip.

News Notes

PURDUE UNIVERSITY announces the Second Annual Indiana Fuel Conference to be held April 4 and 5 at Lafayette, Ind., under direction of the Engineering Extension Department and the School of Mechanical Engineering with the School of Chemical Engineering coöperating. This will be a two-day educational conference devoted to commercial and domestic fuel problems with special emphasis on Indiana fuels. Further detailed information regarding the conference can be obtained from the Engineering Extension Department, Purdue University, Lafayette, Ind.

ANNOUNCEMENT is made of the combination of the Shepard Electric Crane & Hoist Co., including its Sprague Division, and the Niles Crane Corp., under the title of the Shepard-Niles Crane & Hoist Corp. The Shepard plant at Montour Falls, N. Y., and the Niles plant at Philadelphia, Pa., will be continued in operation. The main office will be at Montour Falls, N. Y. The officers of the Shepard-Niles Crane & Hoist Corp. will be Colonel Edward A. Deeds, chairman of the board; S. G. H. Turner, chairman of the executive committee; Frank A. Hatch, president; Sydney Buckley, first vice-president; James A. Shepard, vice-president; Robert T. Turner, vice-president.

GENERAL REFRACTORIES Co., Philadelphia, Pa., has changed the address of its Detroit office to 6-230 General Motors Bldg., Detroit, Mich. The office is in charge of J. L. Graham.

WAGNER ELECTRIC CORP., St. Louis, Mo., has recently placed on the market a rubber mounted motor, the 57RA, developed especially for the electric refrigeration industry. The motor proper is insulated from the supporting cradle-shaped base by rubber bushings designed to absorb any vibration that may be produced, at the same time maintaining the entire machine rigid with perfect shaft alinement. The new type of mounting has been effected without a change in over-all dimensions. The motor itself, it is stated, has been altered to make it more quiet and to improve electric performance. The rocker arm has been designed to eliminate brush noise during starting and stopping. The motor is of the brush lifting type, the brushes being lifted off the commutator as soon as the motor attains operating speed.

NEW YORK EDISON Co., New York City, has awarded a contract to the International Combustion Engineering Co., New York, for three boilers for its new East River generating station on Fourteenth Street. The boiler units will be the largest ever built, with overall height of 95 ft., furnaces 23 ft. wide and extending back 65 ft. with fin-tube water walls. The boilers will be of double Ladd type, designed to furnish a maximum of 800,000 lb. of steam an hour at a temperature of 700 deg. F., with pressure at 425 lb. per sq. in. It is estimated that each boiler will require 80,000 lb. of coal an hour, or approximately 1000 t. per day, when operated continuously at that rate. With a heating surface of 60,000 sq. ft. each, it is claimed that the compactness of the battery will make the boilers not only the greatest producers of steam in the world but also the most economical with regard to space occupied and coal consumed. The boilers are to be delivered in about 4 mo. The new units will supply steam for the largest single-shaft, single-unit, turbine generator in the world, a 150,000-kw. machine, now being constructed by the General Electric Co. It is interesting to note that the station will house, as well, the largest pumping plant now in existence, with a total circulating capacity of 1,400,000 g.p.m., or approximately 1,750,000,000 gal. in 24 hr. The complete unit is scheduled to be ready for service next September.

BRADSHAW & Co. has recently been organized to represent manufacturers of power plant and steel mill equipment in the Pittsburgh district. The new company is located at 530 Fourth Ave., Pittsburgh, Pa. Grant D. Bradshaw is president; he was president of Andrews-Bradshaw Co. from its organization in 1915 until its consolidation with Blaw-Knox Co. on January 1, 1928. During 1928, he was manager of the Andrews-Bradshaw Division of Blaw-Knox Co., resigning the first of the year to organize Bradshaw & Co.

FRANK R. WHEELER, who has been intimately connected with the condenser business for the past 25 yr., has been appointed manager of the condenser department of the Elliott Co. with offices at Jeannette, Pa. Mr. Wheeler assumed his new duties on January 1. He was formerly in charge of the Chicago office of the C. H. Wheeler Mfg. Co.

ON SUNDAY, December 30, a fire occurred on the property of the New York Steam Corp., New York City, adjacent to the Kip's Bay station. According to a statement by the corporation, the fire started from an unknown origin, probably spontaneous combustion in some excelsior packing which had been placed in a storage yard near the steam generating plant, and was in no sense due to any feature of the operation of the steam station. The fire did considerable damage to a covered storage shed and to an old brick building used for storage and similar purposes. The Kip's Bay station itself was scarcely threatened by the flames and suffered no damage whatever. Station operation was carried on during the period of the fire and thereafter without the slightest interference because of the fire in the storage yard.

Catalog Notes

COMMON SENSE About Bearings is a booklet which tells the story of Bearium metals and discusses the problems of bearing design and construction. It was written by Dr. H. M. Rees and is sent out by Bearium Bearings, Inc., 261 Franklin St., Boston, Mass.

ENGBERG GENERATING SETS of the alternating current type are described in Catalog No. 801 by Engberg's Electric and Mechanical Works, St. Joseph, Mich. Details of engines are given and there are tables of dimensions and blue prints.

QUIGLEY GUN for applying emulsified asphalt and emulsified asphalt mixtures is described in a recent folder put out by the Quigley Furnace Specialties Co., Inc., 26 Cortland St., N. Y.

THE THOMAS AUTOMATIC STOKER is illustrated and described in a four-page leaflet by the Thomas Stoker Co., 5906 Park Ave., Cleveland, Ohio.

PUBLICATION DMF-5130 of the Westinghouse Electric and Manufacturing Co., South Philadelphia Works, Lester Branch, Philadelphia, Pa., describes stokers for boilers and industrial furnaces.

MERCOID CONTROLS are described in a thirty-two-page bulletin by American Radiator Co., 40 West 40th St., New York City.

GREEN'S DUSTRAP for eliminating dust from flue gas of power plants is described and illustrated in a four-page bulletin, No. 159, by the Green Fuel Economizer Co., Beacon N. Y.

"REDUCING POWER PLANT UPKEEP" is the title of a 36-page, illustrated bulletin discussing methods of doing this by the use of Budd Versatile Stokers. It is issued by Budd Grate Co., 2011 East Hagert St., Philadelphia, Pa.

FALK herringbone-gear speed reducers are described and illustrated with tables of dimensions in a sixty-eight-page bulletin No. 190 by the Falk Corp., Milwaukee, Wis.

MAIN LINE STATION PIPE LINE PUMPS are described and illustrated in an eight-page bulletin by Wilson-Snyder, Pittsburgh, Pa.

IMPROVED HAND TACHOMETERS are described in an eight-page bulletin by O. Zernickow Co., 15 Park Row, New York City.

BIASBRIX for furnace walls are described in the four-page leaflet issued by General Refractories Co., 106 South 16th St., Philadelphia, Pa. The company is also issuing a folder describing Standard silica bonding cement.

MARLEY SPRAY COOLING TOWERS are described and illustrated in detail in a new bulletin issued by The Marley Co., 1737 Walnut St., Kansas City, Mo. Besides details of the cooling towers, tables of pipe friction, water quantities, psychrometric tables and other data are presented. The Marley Company has also issued an eight-page, illustrated bulletin describing the Marley steam purifier.